INJURIOUS INSECTS

How to Recognize and Control Them

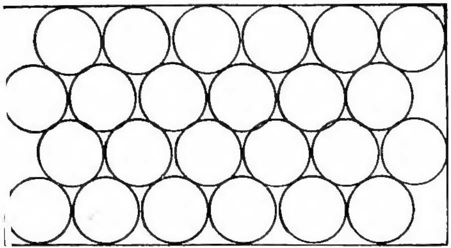
By

W. C. O'Kane

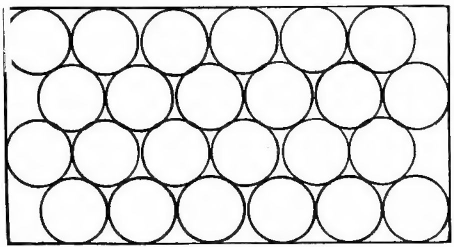
		Fungicides			Contact Insecticides					
		Bordeaux	Lime-Sulphur	Iron Sulfid	Cyanid Fumigation	Tobacco	Soaps	Emulsions	Alkalies	Acids
Stomach Poisons (Arsenicals)	Paris Green........	A-1	D	A-1	D	?	D	D	D	D
	Calcium Arsenite.	A	D	A		A	D	D	D	D
	Lead Arsenate ... (Acid)	A-1	?	A-1		A	D	D	D	C
	Lead Arsenate .... (Neutral)	A	B	A		A	A	A	A	D
	Zinc Arsenite	?	D	A-1		A	D	D	D	D
Contact Insecticides	Lime-Sulphur.....	?	—	—	A	A	C	D	C	C
	Emulsions	?	D	C		A-1	A	—	D	D
	Soaps	A-1 or B	C	C		A	—	—	A	C
	Tobacco	C or D	A	A	A	—	—	—	B	A
	Cyanid Fumagat'n	D	A							
	Acids	D	C	D					C	
	Alkalies	B	C	D						

Class A-1—Better results by mixing A—Properties not changed by mixing	Compatible
B—Efficient, non-injurious C—Inefficient, non-injurious D—DANGEROUS MIXTURE	Incompatible, chemically

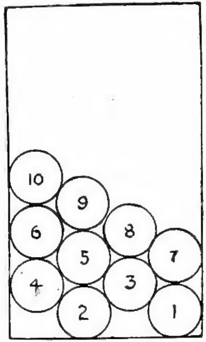
[Arranged by Geo. P. Gray]



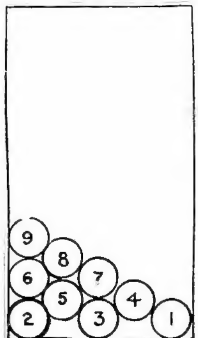
First and Third Layers



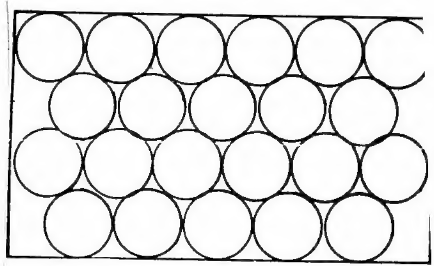
Second and Fourth Layers
Showing diagonal 2/2 pack, 4 layers, 96 apples



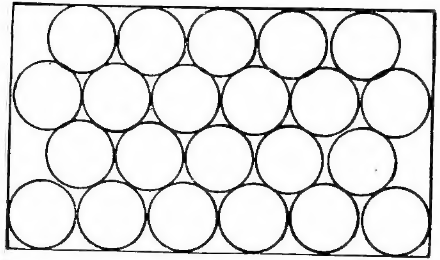
How to Start a 2/2
Diagonal Pack



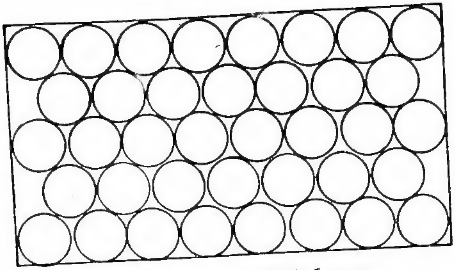
How to Start a 3/2
Diagonal Pack



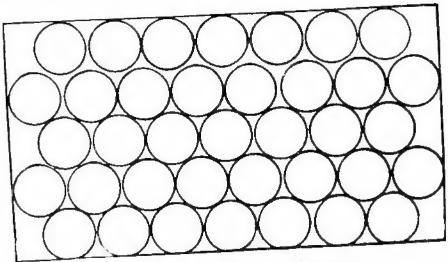
First and Third Layers



Second and Fourth Layers
Diagonal 2/2 pack, 4 layers, 88 apples



First, Third and Fifth Layers



Second and Fourth Layers
3/2 pack, 4½ tiers, 5 layers, 188 apples
If layers are reversed there will be 187 apples

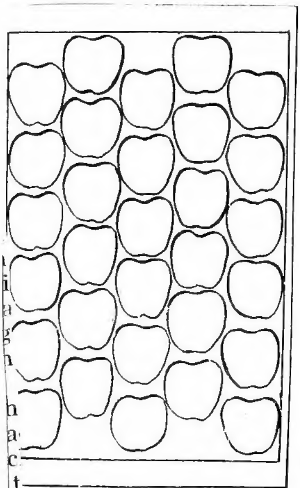


Figure 26—150 Apples
Northwest Standard Box

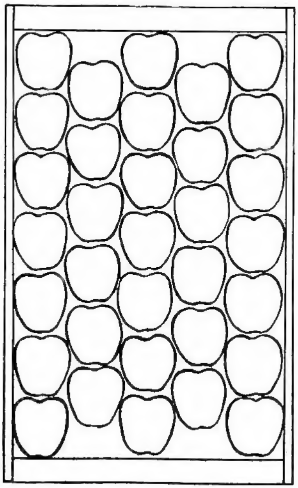


Figure 28—163 Apples
Northwest Standard Box

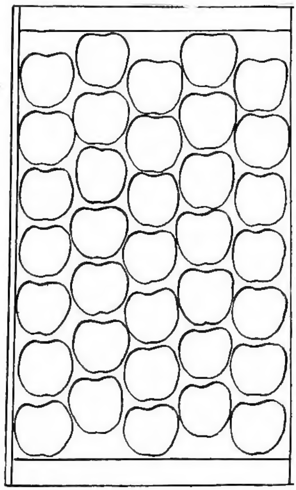


Figure 29—175 Apples
Northwest Standard Box

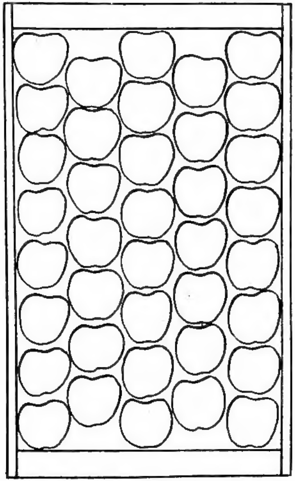


Figure 31—188 Apples
Northwest Standard Box

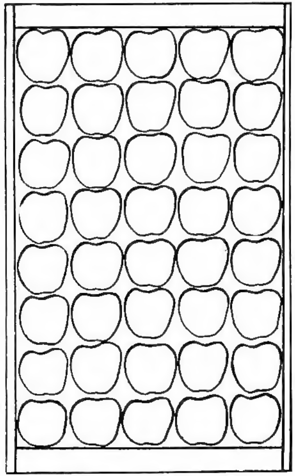


Figure 32—200 Apples
Northwest Standard Box

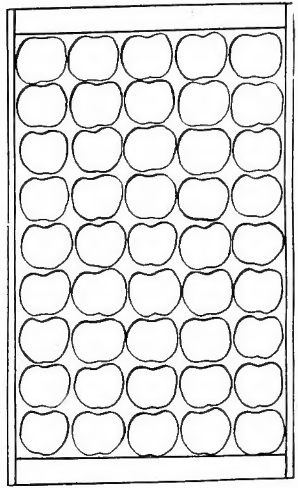


Figure 33—225 Apples
Northwest Standard Box

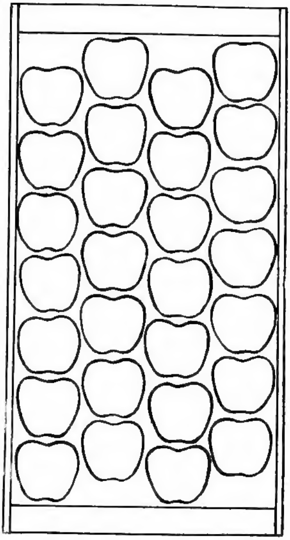


Figure 18—112 Apples
Northwest Standard Box

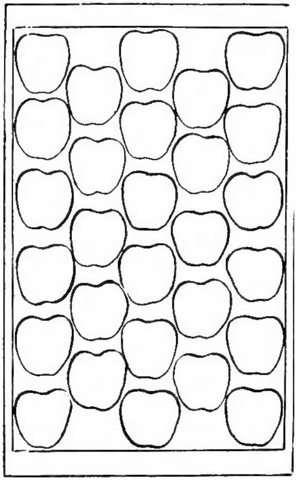


Figure 24—138 Apples
Northwest Standard Box

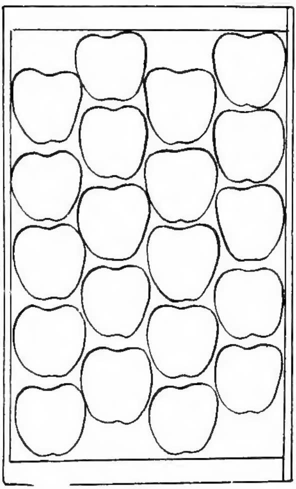


Figure 10—80 Apples
Northwest Standard Box

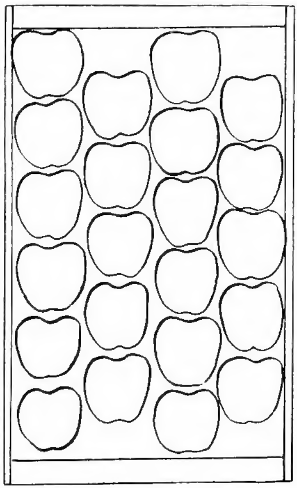


Figure 12—88 Apples
Northwest Standard Box

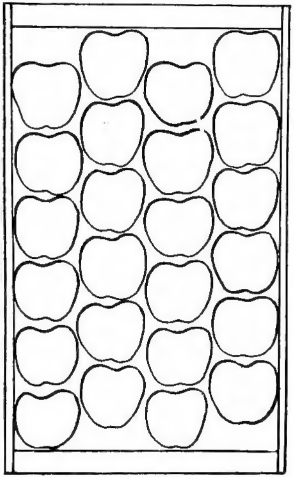


Figure 13—96 Apples
Northwest Standard Box

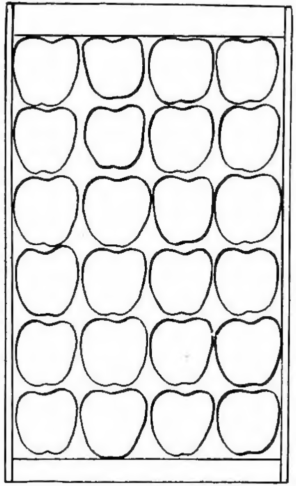


Figure 14—96 Apples
Northwest Standard Box

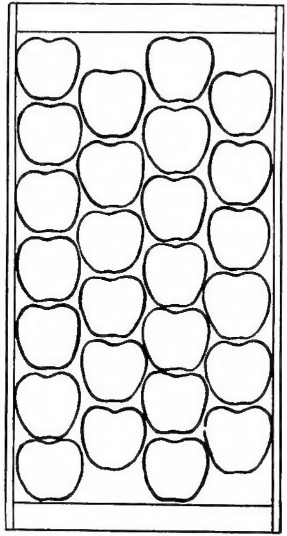


Figure 16—104 Apples
Northwest Standard Box

Apple Packs in the Standard Apple Box

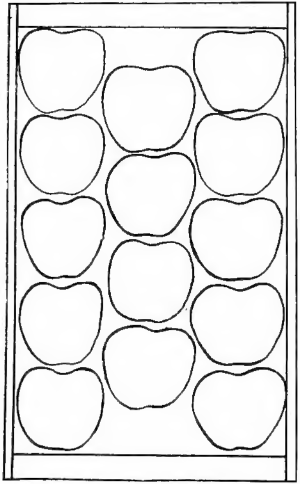


Figure 1—41 Apples
Northwest Standard Box

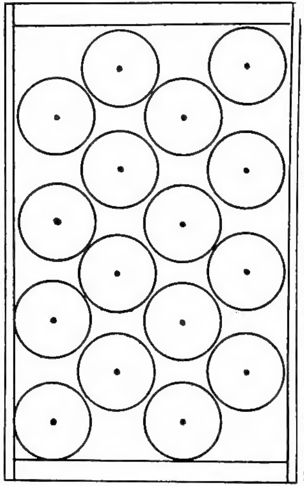


Figure 7—64 Apples
Northwest Standard Box

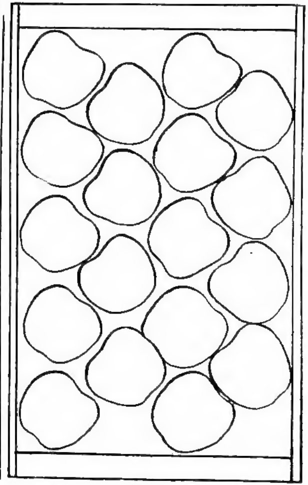
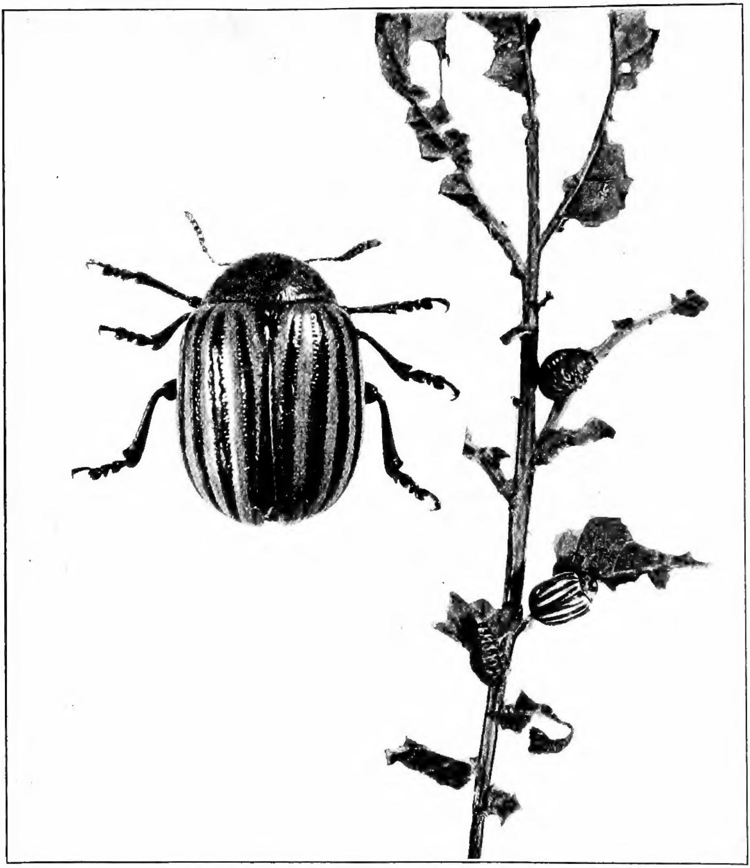


Figure 8—72 Apples
Northwest Standard Box

10½x11½x18 Inches, Inside Measurements



THE COLORADO POTATO-BEETLE.

Forerunner of Modern Methods of Insect Control.

Original. *See pages 63 and 145.*

INJURIOUS INSECTS

HOW TO RECOGNIZE AND CONTROL THEM

BY

WALTER C. O'KANE

ENTOMOLOGIST TO THE NEW HAMPSHIRE EXPERIMENT STATION
AND PROFESSOR OF ECONOMIC ENTOMOLOGY IN
NEW HAMPSHIRE COLLEGE

ILLUSTRATED WITH 600 ORIGINAL PHOTOGRAPHS

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TO

HERBERT OSBORN

DEVOTED SCIENTIST · INSPIRING TEACHER

GENUINE FRIEND

ACKNOWLEDGMENT

THE author wishes to acknowledge his obligation to the many friends and co-workers who loaned or gave specimens needed for the preparation of the illustrations in this book.

While all of the illustrations are original and are prepared from photographs by the author, it would not have been possible to carry through this part of the work without the help of others.

The late Dr. J. B. Smith gave freely many excellent specimens from his collections. A great deal of valuable material was furnished by Dr. E. P. Felt. Special acknowledgment is due also to Dr. L. O. Howard and his associates, Mr. A. L. Quaintance, Dr. F. H. Chittenden, Mr. W. D. Hunter, Mr. F. M. Webster, Mr. E. A. Schwarz, Dr. A. D. Hopkins, Dr. H. G. Dyar, Mr. S. A. Rohwer, and Mr. Otto Heidemann.

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Grateful acknowledgment is here made to the author's assistants, Miss Cornelia F. Kephart and Mr. C. H. Hadley, Jr., for their invaluable and skillful help throughout the work of preparing both illustrations and manuscript.

ARRANGEMENT OF INJURIOUS SPECIES IN THIS BOOK

The insect pests described in this book are grouped as follows:

1. Pests of garden and field crops; including all injurious species commonly found on such plants as corn, potatoes, cucumbers, wheat, squashes, and the like. With these are included pests of greenhouses.

2. Pests of orchard and small fruits: the common injurious species of apples and other tree fruits, currants and similar bush fruits, and strawberries or other low-growing plants, usually designated as fruits.

3. Pests of the household, of stored products, and of domestic animals. These comprise the common injurious species that do not feed on living plants.

Within each of the first two groups the various species are arranged according to *the place where they are found at work.* Thus, insects that work within the soil are treated first; then the borers found within stem, trunk, or imb; then the pests found feeding on the surface of stem or trunk; then the leaf feeders; and finally the insects attacking flower or fruit. Among leaf feeders, again, the insects are grouped according to their general characteristics, whether caterpillars, sucking bugs, and so on.

The page headings are arranged to serve as an index to the place where an insect is found at work, and its general characteristics.

The author hopes by this means to facilitate the identification of a pest by those who are not familiar with insects, and to avoid as far as possible the duplication inevitable where one attempts to group pests according to host plants — a confusion unavoidable because so many of our common pests feed on several varieties of plants, and may properly be listed as well under one as under another.

CONTENTS

PART I

THE STRUCTURE, HABITS, AND CLASSIFICATION OF INSECTS

INJURIOUS INSECTS

CHAPTER I

Introduction

The Tax paid to Insects

Insects exact of the human race an enormous toll in property injured and destroyed. Unfortunately, in the interrelations of life, most things that man desires, uses, or needs are the natural food of one or another species of insect, usually of many.

Specific examples of insect depredations give one some notion of the total. Thus, in a limited area in southern Indiana and near-by counties, a species of cutworm attacking corn caused a loss in one year, 1908, of $200,000. The tobacco flea beetle in a single season, in Kentucky and Tennessee, inflicted damage to the extent of $2,000,000. Injury by a plant louse, the pea aphis, in two years of abundance, was estimated at $7,000,000. In the Black Hills National Forest, a species of beetle has destroyed timber representing at least 1,000,000,000 feet of lumber. The annual price of the boll weevil to cotton growers is figured at $15,000,000 to $30,000,000. Losses due to the cattle tick reach a total of $40,000,000 each season. In a single year of excessive abundance the Hessian fly exacted from our farmers an estimated total of $100,000,000. In Ohio the yield of wheat in that one season dropped from 15 bushels per acre to 6. The ravages of the chinch bug in our crops of wheat and corn in the last 60 years are believed to reach the sum of $350,000,000.

Yet these examples are but one phase of the matter, representing a few of the notable insect outbreaks that have been studied and esti-

mated. By far the greater part of the annual toll goes unrecorded, — often unnoticed. Each season every crop on every farm pays its tax, whether large or small, to the busy, six-footed creatures that look to it for food. It is only when we stop to consider what this total must be, reckoned as a percentage of the value of all crops combined, that its tremendous proportions become evident.

The best observers agree that, in the average, insect depredations equal at least 10 per cent of the value of all farm crops. Our agricultural products in this country have now reached an annual worth of $10,000,000,000. The total damage wrought by insects, therefore, may fairly be placed at $1,000,000,000 each season! This is nearly five times as great as the combined appropriations for the United States army and navy; is equal to the entire bonded debt of the United States; is more than four times the annual property loss by fire; more than fourteen times the annual income of all colleges in this country; is sixty times greater than the funds allotted annually to the United States Department of Agriculture.

Value of a Knowledge of Insects

Unquestionably, the loss due to insect attack may be reduced materially by the adoption of proper methods of prevention and control. In many cases, the program to adopt involves no direct fighting, such as spraying, but simply the shaping of farm, garden, or orchard practice along lines unfavorable to the insects concerned — such matters as judicious rotation of crops, or cleaning fields of weeds. To-day's warfare against insect pests strives toward prevention as well as cure.

In order to plan our campaign intelligently we need to know the more important general facts about insects as a class: the main characteristics of the different groups with which we have to deal; how they have fitted themselves to survive and multiply; what measures of control are adapted to particular groups; how the structure and habits of one group render it susceptible to certain kinds of control measures, such as spraying, while in other groups wholly different measures are necessary. To know these general facts is to possess a fundamental advantage in conducting successful warfare. Not to know them usu-

ally means the loss of time and money in attempting unsuitable remedies or neglecting good opportunities.

Characteristics of Insects

The place of insects in the animal world is in a group known as Arthropoda, a word meaning "jointed foot." They are related on the one hand to spiders, scorpions, and centipedes, and on the other to crabs, crayfish, and the other crustaceans. With these animals they have various points in common; for example, a hardened body wall or "external skeleton," jointed legs occurring always in pairs, and a body made up of distinct rings or segments.

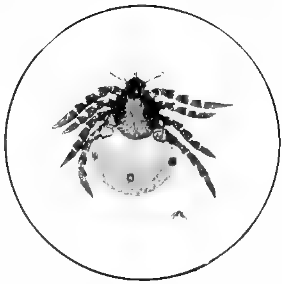

Fig. 1.—A mite. An arthropod, related to insects. Enlarged and natural size. Original.

Other characteristics are peculiar to insects alone, and serve to define them. These are as follows: a body composed of three distinct regions, head, thorax, and abdomen; one pair of compound eyes; one pair of antennæ, or "feelers"; three pairs of legs; two pairs of wings; and a peculiar, complicated type of growth, called metamorphosis, by which the individual goes through three or four unlike stages in its life round.

Fig. 2. — A typical insect, showing the parts of the body and the attachment of appendages. Original.

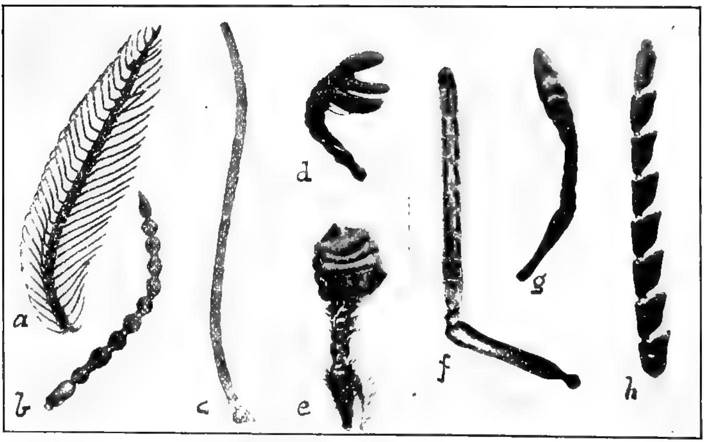

Fig. 3. — Types of antennæ.

a, pectinate; *b*, moniliform; *c*, filiform; *d*, lamellate; *e*, capitate; *f*, geniculate; *g*, clavate; *h*

CHAPTER II

The Parts of an Insect's Body

The Head

Adult insects have a more or less distinct head, varying greatly in shape according to the habits of the species.

Prominent on either side, near the top of the head, are usually to be seen the compound eyes. These are very large in some groups, such as the horseflies or dragon flies, which need to have especially good vision, but are absent in some other groups, such as certain parasites, which have little need of the ability to see. A compound eye is made up of many lenses, each with its own sensitive area and nerve. The number of these lenses often is great; the common house fly has about 4000 on each side.

Fig. 4. — Head of a beetle, showing mouth parts. Enlarged and natural size. Original.

Between or above the compound eyes are usually three simple eyes. These are small, but can be made out readily by looking closely.

Near the compound eyes are the antennæ, or "feelers." Their shape is diverse with the different groups, and is one of the valuable means of determining the identity of many insects, or of placing a specimen in its proper group. Eight or ten general types of antennæ are recognized.

The remaining prominent structures on the head of an insect are the mouth parts. From a practical standpoint, there is no other one thing in the makeup of an insect's body so important as the type of mouth parts in a given pest.

All insects may be divided into two classes, according to whether they obtain their food by biting and chewing, or by sucking; in other words, whether they have biting or sucking mouth parts.

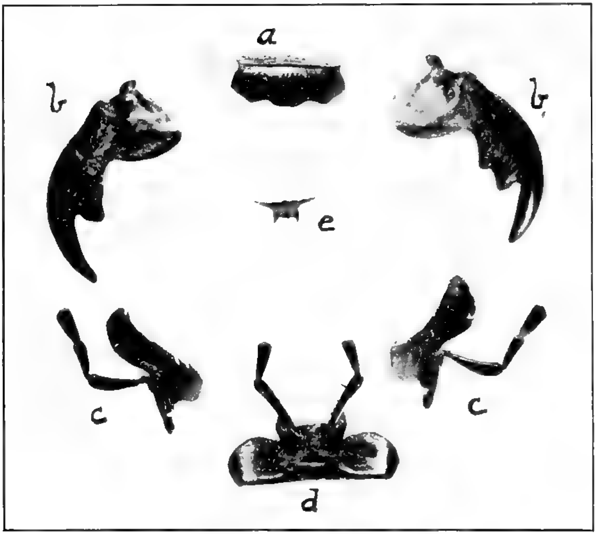

FIG. 5.—Mouth parts of a beetle.

a, labrum; *b*, mandibles; *c*, maxillæ; *d*, labium; *e*, hypopharynx. Original.

If we examine the head of a beetle, for instance, we shall find that it possesses a distinct pair of jaws, or mandibles, obviously intended for chewing or biting. Above these is an upper lip, or labrum; below is a pair of maxillæ, serving to hold the food and otherwise to assist in eating; and below these a lower lip or labium. If we look closely, we shall be able to find between the mouth parts the insect's tongue, or hypopharynx.

But if we observe the head of a squash bug, we find no jaws or other parts that would serve to chew or bite. Instead there is a stout beak, and if we were to dissect this, we should find that it contained a tube for sucking up plant juices or other fluids. In addition, we should find in most insects of this type, two or three pairs of lancets within or close to the beak, used to puncture or rasp the tissues so as to induce a greater flow of the juices.

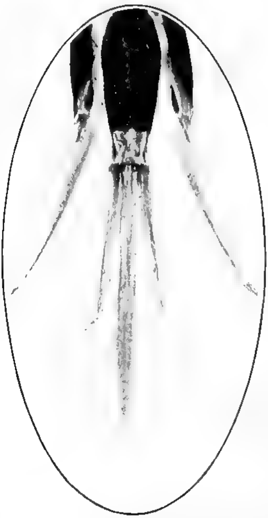

FIG. 6. — Mouth parts of a honeybee. Enlarged. Original.

FIG. 7. — Mouth parts of a horsefly, fitted for piercing and sucking. Enlarged. Original.

Insects with biting mouth parts may be killed by covering the plant on which they feed with a poison, such as lead arsenate. But insects with sucking mouth parts do not eat the surface of the plant and cannot be killed by applications of stomach poison. For the latter other remedies must be used, such as some substance that will kill the insect by corrosive action on its body.

The Thorax

The middle part of an insect's body is called the thorax. Usually it has three distinct rings, or segments. On each segment is a pair of legs and on each of the last two is a pair of wings, except in the group of two-winged flies, which have only a single pair, on the middle segment.

An insect's leg consists, typically, of a small joint next the body, the trochanter; a large and heavy joint, the femur; a slender tibia;

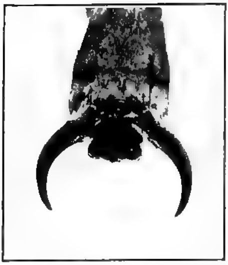

FIG. 8.—Foot of an insect, showing claws and pulvillus. Enlarged. Original.

and a foot, or tarsus, made up of five joints, or sometimes less. On the end of the tarsus often occur claws between which is a small pad, or pulvillus.

The wings vary greatly in size, shape, and texture. They constitute an important character in separating insects into various groups, as will be seen. For example, beetles are easily recognized by the possession of a front pair of wings that are hardened or horny and serve simply as covers for the large, membranous hind wings.

The Abdomen

The third, or hind part of an insect's body is called the abdomen. It consists often of ten rings or segments, though frequently this number is reduced. There are never any legs on the abdomen of the adult insect. At the hind extremity in both sexes are the reproductive organs. The two sexes are invariably separate in insects, and never normally combined in a single individual as in some other forms of lower animal life.

CHAPTER III

The Internal Structure of Insects

How Insects Breathe

All insects, even those living in water, need air. But their method of obtaining it is entirely different from that developed in higher animals. No insect has nostrils, or any opening in its head through which it breathes. Instead, there is a row of small apertures, called spiracles, down each side of its body, one on each segment, beginning with the second or third segment of the thorax and extending back along the rings of the abdomen. The spiracles of each side open into an air tube running lengthwise of the insect, just within the body wall. From these main tubes smaller tubes diverge, and these in turn branch and rebranch, growing constantly smaller, until the finer tubes permeate every part of the insect, even to the tips of the antennæ and the joints of the feet. The tubes are known as tracheæ and the entire group as the tracheal system. The smaller

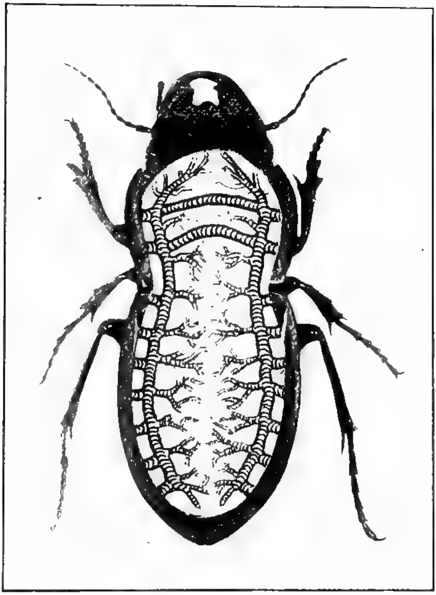

Fig. 9. — Tracheal system of an insect. (Diagrammatic.) Original.

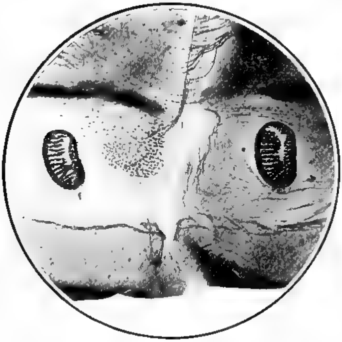

Fig. 10. — Spiracles of a grasshopper. Enlarged. Original.

tracheæ are extremely thin walled, and the oxygen that they contain is thus brought to the various tissues. Air circulates slowly in the tracheæ. The openings or spiracles are guarded by various devices, such as a fringe of hairs.

The Circulatory System

The entire body cavity of an insect is bathed in a yellowish or greenish fluid that we speak of as its blood. There is no closed system of blood vessels, as in the higher animals, whose blood circulates in arteries, veins, and capillaries. In insects the blood flows freely around the internal organs and through the tissues.

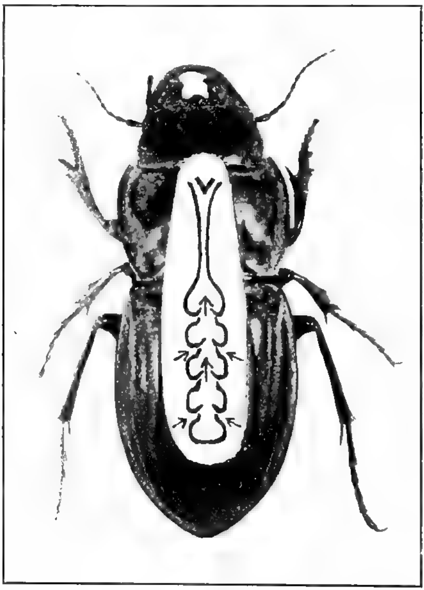

Fig. 11. — An insect's heart. (Diagrammatic.) Original.

There is a heart, however, which keeps the blood moving. It is an elongated structure, situated just beneath the upper surface of the insect's body, and consists of a series of chambers, each with valves opening from the body cavity into the chamber, and with another valve opening into the next chamber toward the front. The

end of the heart toward the head opens into the body cavity. When the heart contracts, the blood it contains is forced forward, and when it expands, more blood is admitted through the side valves.

The Digestive System

There is a fairly close parallel between the digestive system of insects and that of some higher animals. The various organs concerned

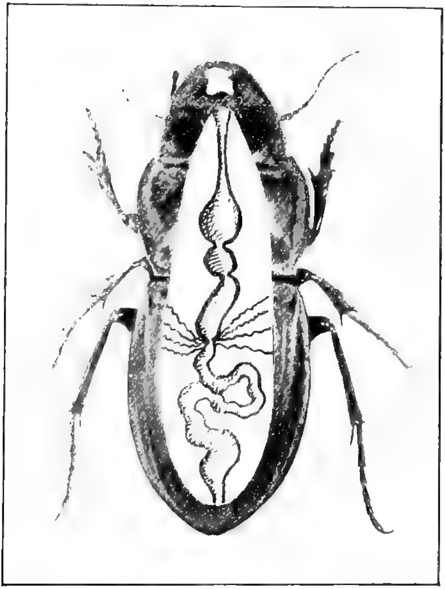

FIG. 12. — Digestive system of an insect. (Diagrammatic.) Original.

are much modified in many species, according to their food habits; but taking a typical group, we find the following parts:

From the mouth the food passes through a pharynx and is conveyed by a gullet or esophagus to a crop, which serves as a storage place. Thence it enters the gizzard, where it is ground up, and so passes on into the stomach, where part of the digestion and absorp-

tion takes place. Thence it enters the intestine, where it is still further digested. The waste is expelled from the hind end of the body.

Opening into the intestine near the stomach are tubes that probably serve as kidneys. They are known as Malpighian tubes.

The Nervous System

Most insects are extremely active creatures, and have a well-developed nervous system.

Taking a simple type, we find that a pair of nerve cords begin in the upper part of the head, encircle the esophagus, one on each side, again come close together or unite, and extend back to the hind extremity of the body, lying just above the lower body wall throughout.

Fig. 13. — Gizzard of a cricket, showing muscles and grinding surfaces. Enlarged. Original.

In the upper part of the head and in the lower part are enlargements, called ganglia, from which are given off branch nerves to the eyes, antennæ, and mouth parts. In the thorax there are three more ganglia, one for each segment, though these may be more or less united. In the abdomen are further ganglia, often somewhat concentrated toward the front end of the abdomen. Many branch nerves arise from the thoracic and abdominal ganglia.

The Fat Bodies

Within the body cavity are many irregular masses of peculiar fatty tissue. The functions of these masses are not fully understood. It is known, however, that reserve food is stored up in them, especially

in the case of caterpillars that are reaching full growth and getting ready to transform.

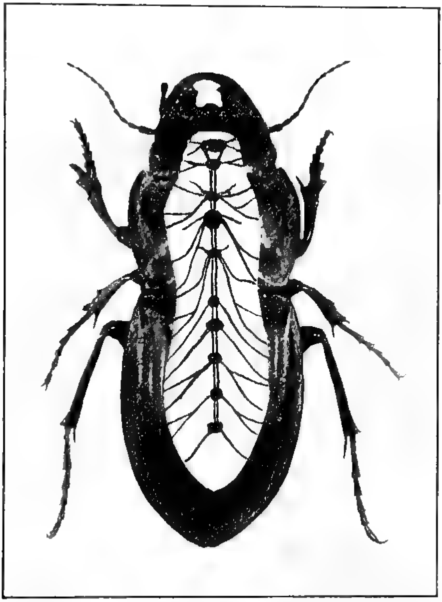

FIG. 14. — Nervous system of an insect. (Diagrammatic.) Original.

The Body Walls

The bodies of most insects are covered with a more or less horny or hard coating, to which the muscles are attached, and which takes the place of the bony, internal skeleton of higher animals. The basis of this coating is a fluid substance called chitin, which hardens on exposure to air. In order to permit of movement, this outer shell is made up of distinct plates, joined to one another by flexible skin.

CHAPTER IV

THE SENSES OF INSECTS

IT is obvious that most insects possess a well-developed power of sight. It is not believed that they have the ability to form images of objects, in other words to "see," with the precision of higher animals. To a limited extent the compound eyes probably give an insect certain powers of forming images up to a short distance — not more than a few feet. They undoubtedly are well adapted to discern movement. The ocelli, or simple eyes, are formed somewhat on the plan of the human eye; but the lens is of fixed focus, and the number of nerves in the retina is comparatively small.

FIG. 15. — Tongue of a cricket. Enlarged and natural size. Original.

The sense of hearing is well known to exist among many insects. The location of the auditory apparatus has been determined in certain species. Thus, the antennæ of some insects are known to have auditory functions; grasshoppers have an "ear" on the first segment of the abdomen; other species have a similar organ on the foreleg.

Most insects have a sense of taste. The hypopharynx, or tongue, and short appendages attached to the maxillæ, or lower jaws, are commonly the seat of this sense.

There is abundant evidence of the existence of a sense of smell. In fact this sense is particularly well developed in many insects, and serves to guide them to their food, to lead the females to the proper plants on which to deposit their eggs, and often to bring the male to

the female at mating season. Minute structures found in the antennæ and the maxillary palpi are commonly the seat of the olfactory sense.

All insects have more or less specially developed parts for exercising the sense of touch. The antennæ, or "feelers," are primarily adapted to serve this function, but hairs or bristles connected with sensory nerves occur at various places over the body. This would be expected, since the body is so completely covered with its armor of chitin.

CHAPTER V

The Behavior of Insects

Most of the movements of insects are automatic responses to a direct external stimulus. For example, ants of certain species always move away from the light; flies, toward it. Roaches will attempt to crowd into narrow crevices, where their body is in close contact all around with the surrounding substance. Some kinds of caterpillars habitually crawl toward the ends of twigs, or contrary to gravity. Aquatic insects move toward water.

Most of the movements of insects, if carefully analyzed, will be found explainable as some of these simple reactions. But there is another group of movements that are really complex. An example is seen in the spinning of its cocoon by a caterpillar. Here we have genuine evidence of the workings of instinct. Yet even these examples of insect behavior have one point in common; they are started by some simple stimulus, and once set going, they invariably are carried out to the same conclusion, regardless of circumstances. Thus, a female codling moth, the parent of the common worm found in apples, frequently lays its eggs on the leaves of trees which are bearing no fruit, with the inevitable result that all its offspring die.

Rarely, in the highly specialized orders, such as the bees or ants, insects are observed to follow a procedure that seems to demand some reasoning power as its basis. An individual apparently will learn by experience, and voluntarily modify its procedure in going through a similar action. Such cases, however, are not common. Most insect behavior is automatic and purely reflex.

CHAPTER VI

How Insects Transform

All insects, except two primitive groups of little importance, go through distinct changes of form in the life round of the individual. These changes constitute what is known as metamorphosis.

Fig. 16. — Illustrating complete metamorphosis. Egg, larva or caterpillar, cocoon and pupa, and adult of the Rusty Tussock Moth, *Hemerocampa antiqua* Linn. Original.

Thus, the cabbage butterfly lays an egg. From the egg hatches a tiny "worm" or larva. The larva grows, and in due time changes

to a "chrysalis" or pupa. And finally, from the pupa emerges the winged butterfly, ready to begin the life round over again. This is an example of *complete metamorphosis,* including four distinct stages — egg, larva, pupa, and adult.

With the squash bug we find the adult laying an egg, as before. But from this egg hatches, not a larva or worm, but a tiny, active bug,

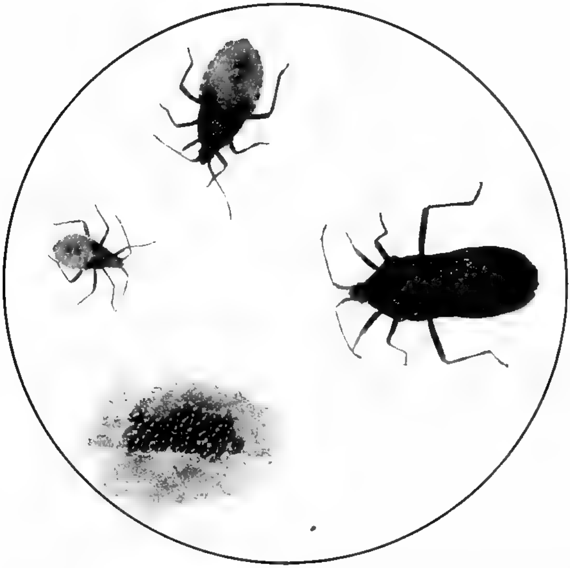

FIG. 17. — Illustrating incomplete metamorphosis. Eggs, nymphs, and adult of the Squash Bug, *Anasa tristis* De G. Original.

similar to the parent insect except that it has no wings. This immature form grows, shedding its skin four or five times, and finally with the last moult acquires its wings and is now a typical adult. The immature stage is known as a nymph, and this is an example of *incomplete metamorphosis,* including only three distinct stages instead of four — egg, nymph, and adult.

In all insects the larval or nymph stage is the period of growth.

To this stage belongs primarily the function of feeding and growing. The adult insect may or may not feed, but it never grows. To the adult stage belongs the function of mating and thus perpetuating the race. The pupa, which we find in insects with complete metamorphosis, represents a resting stage devised to accommodate the tremendous changes taking place in the transformation of the wormlike larva into the winged adult.

The type of metamorphosis constitutes a fundamental character in separating insects into groups.

CHAPTER VII

How Insects are Classified

More than 350,000 distinct species of insects have been described. In addition at least as many more remain to be studied and classified. Obviously, in all this array, there must be certain groups that have many characters in common, or give indication that at some period in the remote past they were derived from common ancestors. These groups are known as Orders.

Fig. 18.—A typical specimen of the order Orthoptera. Original.

There are more than twenty recognized orders of insects, but the great majority of injurious species are included in ten principal economic orders. The leading characteristics distinguishing these from one another are the type of metamorphosis, the kind of mouth parts, the number, shape, and texture of the wings, the presence or absence of compound eyes, the type of antennæ, and the shape of the body.

The ten principal orders and their characteristics are as follows:

Orthoptera

Familiar to all are many of the species that go to make up this order: the grasshoppers, katydids, crickets, and roaches.

The entire group is characterized by incomplete metamorphosis. The immature form just hatched from an egg is quite similar in appearance to the adult, except that it is very much smaller, and that it has no wings. As it grows, wing pads develop, and finally, with the last moult, the adult comes forth.

All insects in this order have biting mouth parts. There are two pairs of wings. The front pair are leathery, and, when at rest, cover the hind pair, which are thin and papery, and are folded in plaits. The antennæ vary, but frequently are quite long and slender.

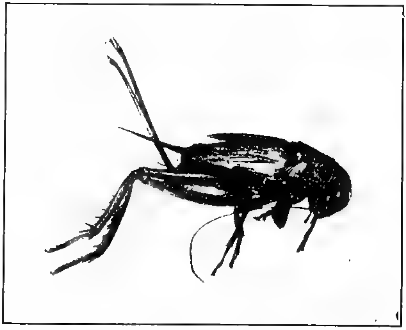

FIG. 19.—One of the jumping Orthoptera, or Gryllidæ. Original.

The order is divided into various subgroups or families. Thus we have the jumping Orthoptera, including the Gryllidæ or crickets, the Acrididæ or grasshoppers, and the Locustidæ or katydids; the running Orthoptera, including the Blattidæ or roaches; the grasping Orthoptera, including the Mantidæ or praying mantids; and the walking Orthoptera, including the peculiar insects known as the Phasmidæ or walking sticks.

There are many injurious pests in this order; some of them, such as the Rocky Mountain locust, famous for the devastation that they have wrought to American farms. The immature stages, or nymphs, as well as the adults, are destructive, though in less degree because they are smaller.

Mallophaga

These are parasitic insects, commonly known as bird lice, although there are some species that infest domestic animals.

The metamorphosis is incomplete. Eggs laid by the adult female hatch into minute creatures looking much like the mature insect.

FIG. 20. — A biting louse. Enlarged and natural size. Original.

The members of this order are plainly adapted for their parasitic life. The body is flattened. There are no compound eyes. Wings are absent. The antennæ are short and simple. The mouth parts are fitted for biting, and the food consists of the hairs or feathers of the host, or loose scales of dead skin. The Mallophaga never feed on the blood of their host, as do the members of the order Siphonaptera, the fleas.

About 2000 species have been described.

Odonata

The adults in this order are the dragon flies, often called "snake feeders" or "darning needles."

Metamorphosis is incomplete. The nymphs, which hatch from the eggs, are aquatic, spending their lives beneath the surface of ponds or streams, where they lead an active existence, capturing and devouring such other forms of animal life as come within their reach. The mouth parts of the nymph are peculiarly adapted to its needs, being provided with a hinged lower lip which can be extended, and which bears hooks on its farther edge. By means of these the nymph is enabled to catch its prey unawares.

The adults are large insects, and have two pairs of strong, narrow,

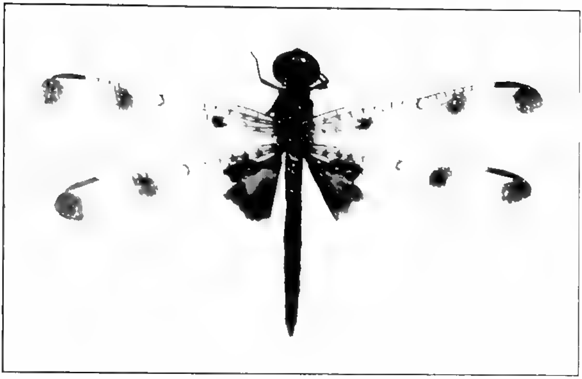

FIG. 21.—Adult dragon fly. Original.

membranous wings. Each wing is marked with a shallow notch about midway along its front margin. Adults as well as nymphs are predacious, living on other insects which they capture. Their mouth parts are of the biting type. They have large compound eyes, — as, indeed, we should expect in insects that live by capturing others. The abdomen is slim, and is never provided with a sting of any sort, as is so often supposed.

Insects of this order are of importance because they make a business of capturing individuals of other species, many of which we may reasonably assume would be injurious.

The order has been carefully studied, and about 2000 species have been described.

FIG. 22. —The empty pupal skin of a dragon fly. Original.

Thysanoptera

The group to which has been given this name is made up of very small insects, many of which the layman will recognize rather by their characteristic work than by acquaintance with the appearance of the insect itself. Their common name is "Thrips."

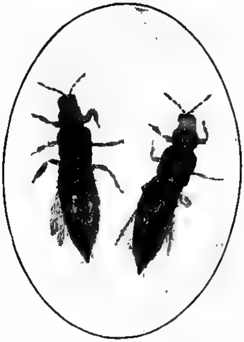

Fig. 23. — Adult thrips, *Euthrips tritici* Fitch. Original.

Metamorphosis is incomplete. Both nymphs and adults are slender insects, provided with sucking mouth parts. The adults have two pairs of peculiar wings, very narrow, almost without veins, and fringed along the margins with a row of long hairs, set close together. The wings are laid along the back when not in use. In most species the adults are not more than one tenth or one twelfth of an inch in length. The antennæ are comparatively short and simple.

Usually the presence of these insects is recognized first by a whitening of the leaves or a shriveling of other parts on which they happen to be feeding. Close examination will then reveal the tiny active insect itself.

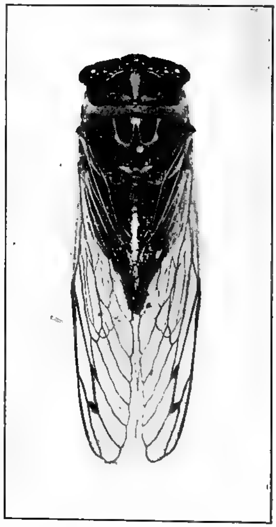

Fig. 24. — A cicada. Suborder Homoptera. Original.

Hemiptera

A large group, including the true "bugs," characterized throughout by sucking mouth parts.

Metamorphosis is incomplete. Active nymphs, which look more or less like the adults except that they have no wings, hatch from the eggs laid by the parent female.

There are two large subdivisions in this order, the Homoptera and the Heteroptera, distinguished from each other by the type of wings, and the manner in which the beak is attached to the head.

In the Homoptera the wings, four in number, are membranous throughout, and when the insect is at rest, usually are held in a slop-

ing position along the back, like the two sides of a hip roof. The common "locust," or cicada, is a familiar example of this suborder. In the Homoptera the sucking beak arises from the hind part of the lower side of the head.

The Heteroptera are well illustrated in the "squash bug." In this suborder the front pair of wings are horny in the half nearest the insect's body, and thinner in the outer half. The hind wings are membranous throughout. When at rest, the front wings are laid along the

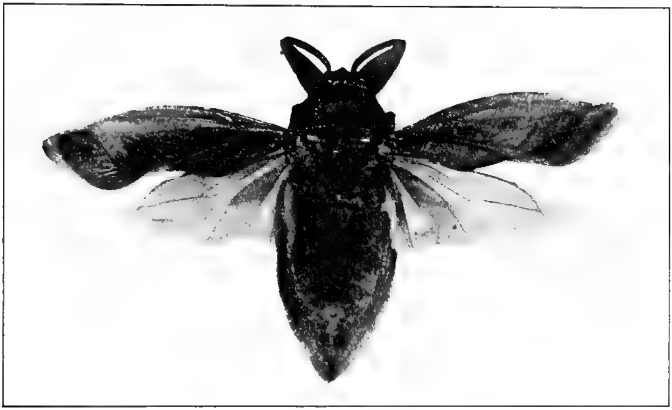

FIG. 25.—The giant water bug, *Lethocerus americanus* Leidy. Suborder Heteroptera. Original.

back, with the thin, outer halves crossed, one on top of the other, while the hind wings are concealed beneath the front pair. Often, when the insect is at rest, its wings look as if they were a part of its body, though there is always the tell-tale diagonal line where the thickened part of the wing gives way to the thinner part. In the Heteroptera the beak arises from the front part of the head, though in many species it is sharply bent so that it points backward beneath the head.

The more important families of **Homoptera** are as follows:

Cicadidæ, the cicadas or, as commonly called, "locusts."

Jassidæ, the leaf hoppers. Destructive pests.

Psyllidæ, the psyllas. Minute, jumping forms. Plant feeders.

Aphididæ, the plant lice.

Coccidæ, the scale insects and mealy bugs.

The more important families of **Heteroptera** are as follows:

Reduviidæ, the assassin bugs. Predaceous on other insects. Occasionally attack man. Have a strong, three-jointed beak.

FIG. 26. — The giant water bug, wings folded. Suborder Heteroptera. Original.

Tingitidæ, the lace bugs. Wings finely reticulate, looking like lace. Plant feeders.

Acanthiidæ, including some plant feeders; also the common bedbug.

Capsidæ, the leaf bugs. Usually small. Often injurious.

Lygæidæ, the chinch bugs. Destructive plant feeders.

Coreidæ, the squash bugs. Often ill smelling. Some species rather large.

Pentatomidæ, the stinkbugs. The family includes both plant feeders and predaceous forms.

Thyreocoridæ, the negro bugs. Very small forms.

Pediculidæ, the sucking lice, parasitic on mammals.

The number of described species in the Hemiptera exceeds 20,000.

Coleoptera

The order Coleoptera includes the beetles, readily distinguished, as a rule, by the fact that the front pair of wings are hardened and act simply as horny coverings for the larger, membranous hind wings, which are folded beneath the others when at rest.

Metamorphosis is complete. There are four distinct stages, instead of three, as with all the other orders mentioned thus far. Eggs are laid by the adults, and from these hatch wormlike larvæ, commonly called

"grubs." A resting stage, or pupa, follows the completion of growth of the grub. Finally from the pupa emerges the adult beetle.

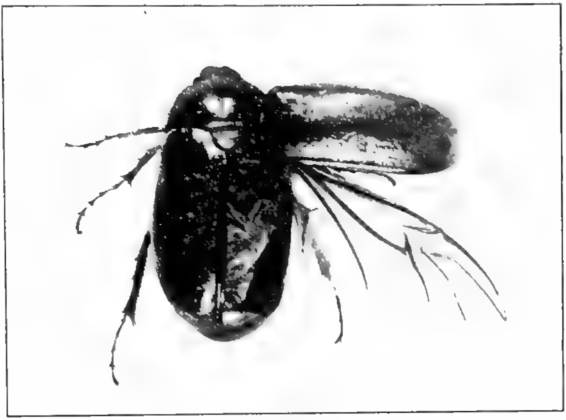

FIG. 27.—A beetle, *Lachnosterna*. Original.

The mouth parts are formed for biting. In one subgroup within this order the head is prolonged in a sort of snout. This is not a sucking organ, but bears at its end true jaws, adapted for biting and chewing. The larvæ or "grubs" of the snout beetles have no legs.

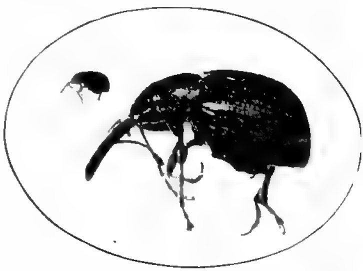

FIG. 28.—A nout beetle, *Rhynchites*. Enlarged and natural size. Original.

The antennæ are of many distinct types, ranging from simple filiform or moniliform shapes to complex types that can only be classed as "irregular." Some of the subgroups are commonly designated according to the kind of antenna; as, for example, the Clavicorns, the Lamellicorns, or the Serricorns.

Something like 20,000 species have been described.

There are many families, in practically all of which are to be found species of importance. A few of the typical families are the following:

Carabidæ, the ground beetles. Active insects both as larvæ and as adults, and usually predaceous.

Silphidæ, the carrion beetles. Larvæ and adults feed on decaying animal matter.

Coccinellidæ, the lady beetles. Both larvæ and adults predaceous. One of the most beneficial families.

Elateridæ, the click beetles. Parents of the wireworms.

Buprestidæ, the adults of the "flat-headed borers."

Scarabæidæ. Large beetles, well illustrated in the "June bug." The larvæ of some feed on decaying animal or vegetable matter, while others are highly injurious.

Cerambycidæ, the parents of the "round-headed borers."

Chrysomelidæ. Typical leaf eaters. Examples are the potato beetle, asparagus beetle, and many others.

Meloidæ, the blister beetles.

Curculionidæ, the curculios. Snout beetles. The larvæ legless grubs.

Siphonaptera

Fig. 29.—Adult flea. Enlarged. Original.

The Siphonaptera include the fleas. The order is a small one, but is interesting because of the adaptations that it exhibits for parasitic or predaceous existence.

Metamorphosis is complete. From the egg hatches a legless larva, slender and wormlike, which later transforms to a pupa, and from this in turn emerges the adult, ready to begin the life round again.

The adults are practically wingless, though small, scalelike projections from the top of the thorax show where the wings should be, and perhaps once were. The body is flattened laterally, thus enabling the insect to slip around easily among the hairs of its host. While the surface of the body is quite smooth and hard, it is provided with regular rows of stiff bristles, pointing backward, which help to force the insect in the direction in which it wishes to go, and likewise help it to escape from the fingers of its captor. A further evidence of its parasitic life is seen in the entire absence of compound eyes. The mouth parts are fitted for sucking.

Diptera

The insects falling within this order are easily recognized from the fact that they have only a single pair of membranous wings. The order includes the groups that we speak of as flies, mosquitoes, midges, and gnats.

Fig. 30. — Adult fly, *Tabanus*. Enlarged to twice natural size. Original.

Metamorphosis is complete. The larva is commonly called a maggot, and is without feet. In most species it has no distinct head. In many subgroups within this order the pupa or resting stage preceding the adult is peculiar in that it is inclosed within the hardened and shortened skin of the larva.

The single pair of wings borne by the adult are on the middle segment of the thorax. On the hind segment are a pair of small knobs, representing the second pair of wings found in other insects.

The mouth parts are primarily of the sucking type, but often are complex, and frequently are modified so that certain of the parts are fitted for piercing or for rasping. Thus, in the horseflies there are sharp lancets in addition to the sucking tube, the former penetrating

the tissues and assisting in bringing on a generous flow of blood, which the latter conveys to the insect's pharynx. In the female mosquito similar structures are found, sharp stylets penetrating the flesh and the pharynx pumping the blood up through a sucking tube.

The antennæ are of various shapes, from the elaborately feathered structures of the male mosquito to the short, peculiar form, ornamented with a prominent bristle, found in many of the so-called "flies."

Classification within the order is complex, and is based partly on the manner in which the pupal skin is ruptured when the adult emerges, partly on the type of antenna, partly on the arrangement of the veins in the wings, as well as other structural peculiarities.

Fig. 31.—Adult mosquito. Enlarged and natural size. Original.

More than 40,000 species have been described.

The number of families is very large, but among the more important groups may be mentioned the following:

Culicidæ, the mosquitoes. A nuisance to man and domestic animals, and in some cases carriers of disease. Larvæ aquatic, as a rule.

Chironomidæ, the midges (but not the so-called midges attacking wheat, clover, and the like). Larvæ often aquatic.

Cecidomyiidæ, the gall midges. Many injurious species, some of prime importance, as the Hessian fly.

Simulidæ, the black flies. Attack man and domestic animals.

Tabanidæ, the horseflies.

Asilidæ, the robber flies. Predaceous on other insects.

Syrphidæ, the syrphus flies. The larvæ of some species are predaceous on noxious insects.

Œstridæ, the botflies. The larvæ are notorious parasites in mammals.

Muscidæ, a very large family including the common house fly.

Tachinidæ, the tachina flies. The larvæ often beneficial because attacking noxious insects.

Anthomyiidæ, including the root maggots.

A special interest attaches to this order because several of its members have been directly connected with the transmission of serious human diseases, as discussed in a later chapter.

Lepidoptera

The insects included within this order are the moths, the skippers, and the butterflies. The main characteristic of the order is the fact that the wings and body are covered with minute scales, which are arranged in definite patterns and often give to the wings beautiful and elaborate colors.

FIG. 32.—Scales from the wing of a butterfly, *Pontia*. Enlarged. Original.

In all Lepidoptera there is complete metamorphosis. The larva is commonly known as a caterpillar, or simply as a "worm," the latter term more frequently attached to larvæ that are not covered with hairs. Thus, on the one hand, we speak of the cabbage worm and the canker worm, on the other the tent caterpillar and the yellow-necked caterpillar. The larvæ have three pairs of legs near the front end of the body, a single pair of legs or claspers at the hind end, and usually two to four pairs of fleshy prolegs between.

All adults in the order Lepidoptera have four wings, except in certain species where the wings are entirely lacking. The mouth parts

are fitted for sucking. The adults in this group take only liquid nourishment, or frequently none at all. The larvæ, however, are provided with well-developed jaws, adapted for biting and chewing. It is in the larval stage that the representatives of this order are injurious. The moth itself, or butterfly, is harmful only in the sense that it is the parent of a succeeding destructive stage.

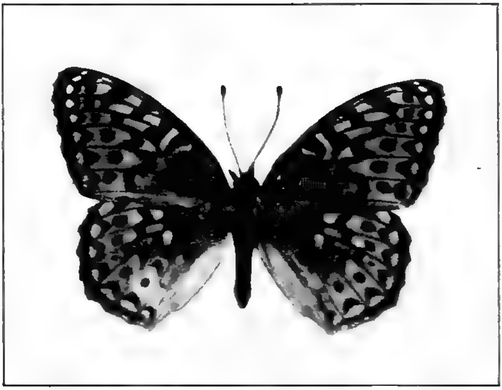

Fig. 33.—A butterfly, *Argynnis*. Original.

The antennæ are of three general types, and separate the order into its subgroups. Butterflies have slender antennæ composed of a large number of indistinct rings or segments, with an enlargement or club at the end. In the skippers the club at the end of the antenna is somewhat elongated, and is turned back at the farther end in a slender hook. The antennæ of moths are more or less feathered, often elaborately so. Butterflies are usually on the wing in the daylight hours, while moths have a tendency to fly at night. Butterflies habitually rest with their wings folded together vertically above the body; skippers may hold the wings in a similar position, or may hold the front wings vertical and the hind wings horizontal; moths habitually rest with their wings held horizontal or rooflike, or curved around the abdomen. The

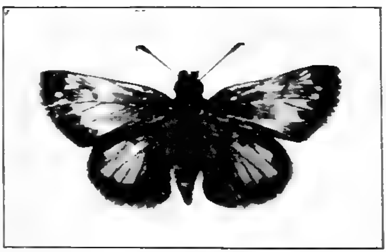

Fig. 34.—A skipper, *Atrytone*. Original.

bodies of butterflies are slender; those of skippers are rather stout; the bodies of moths are typically heavy.

About 60,000 species are known. In classification among this tremendous number use is made of the markings on the wings, but especially of the veins in the wings.

The number of families is very large, and injurious species are found in a large proportion of them. Examples are as follows, though this list necessarily is brief and by no means representative of the entire order:

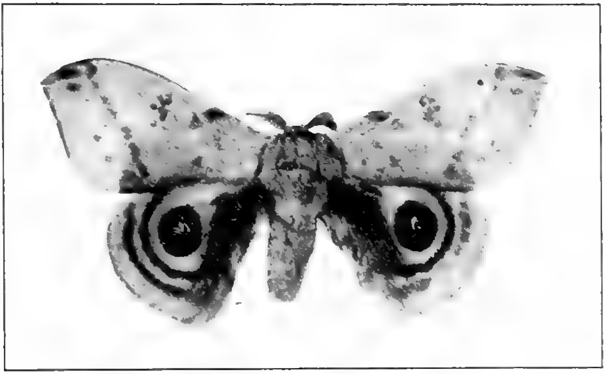

FIG. 35.—A moth, *Automeris*. Original.

Cossidæ, the carpenter moths. Larvæ bore in the trunks or branches of trees. Pests of shade trees.

Pyraustidæ. The larvæ of many species are leaf rollers, and are serious pests.

Grapholithidæ. Adults small. The family includes the codling moth, the bud moth, and other pests.

Tortricidæ. The larvæ usually work within webs.

Tineina, a superfamily of very small moths, the larvæ of which often are leaf miners, but sometimes construct cases within which they feed, as in the case-bearing clothes moths.

Sesiidæ, the clear-wing moths. Larvæ often borers and very injurious, as the peach-tree borer, the squash borer, and others.

Notodontidæ. Larvæ large and usually feed exposed. Examples are the yellow-necked and the red-humped caterpillars.

Geometridæ. Parents of the "measuring-worms."

Noctuidæ. An immense family. The moths fly at night. The larvæ include many of our worst insect pests, such as the army worm, cotton boll-worm, and cutworms.

Lymantriidæ, the tussock moths.

Sphingidæ, the hawk moths. Large insects. Larvæ conspicuous. Example, the tomato worm.

Saturniidæ, the silkworm moths. Larvæ large and armed with tubercles or spines.

Lasiocampidæ. The larvæ often construct large nests, as the tent caterpillar.

Pieridæ. A common family of butterflies, including the imported cabbage worm.

Hymenoptera

The order Hymenoptera includes the bees, ants, wasps, sawflies, and a host of parasitic species, many of which are extremely minute.

Metamorphosis is complete. The larva is grublike or wormlike. Often the pupa is inclosed in a cocoon.

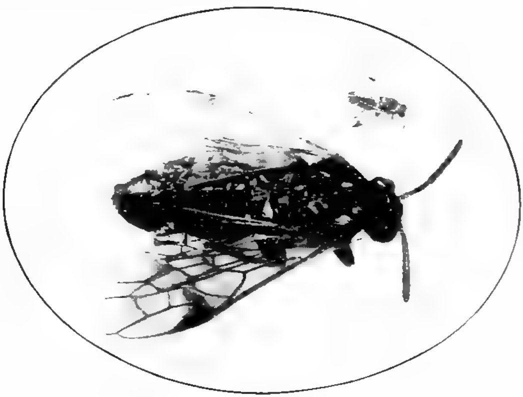

Fig. 36. — A sawfly. Enlarged and natural size. Original.

Adults in this order are characterized by the possession of two pairs of wings, both pairs membranous, the front pair larger than the hind pair. The mouth parts are complex, and are adapted for biting and for sucking. However, the structure of the mouth parts is not usually of direct economic importance, since the adults do not habitually feed on or destroy that which is of value to man.

Fig. 37. — The saws of a sawfly. Enlarged and natural size. Original.

In one subgroup of the Hymenoptera the abdomen of the adult is broad at the point where it joins the thorax; in other words, the insects are "broad waisted." This section includes the Tenthredinidæ or sawflies, a family containing many injurious species. The name sawfly is given to this family because the end of the abdomen in the adult female is provided with genuine saws, which it uses in making a place for the deposition of its eggs. Sawfly larvæ strongly resemble the larvæ of the Lepidoptera, but may be distinguished from them by the number of prolegs — the false legs situated behind the three pairs of genuine legs near the front end of the body. The larvæ of sawflies usually have six to eight pairs of these prolegs, while those of the butterflies or moths have never more than five pairs. Examples of injurious sawflies are seen in the pear slug and the currant worm.

Fig. 38. — An ichneumon, *Pimpla*. Original.

A closely related subgroup of the Hymenoptera comprises a number of families in which the female is provided with a boring apparatus at the hind end of the abdomen. These families include some of our important beneficial species living as parasites in the bodies of other insects, the Ichneu-

monidæ Chalcididæ, and others. With these the abdomen is joined to the thorax by a narrow waist.

FIG. 39. — Adult winged ant. Enlarged and natural size. Original.

Finally there are the stinging Hymenoptera, which also are narrow-waisted, like the boring Hymenoptera. Typical specimens are the common bees, wasps, and ants. It is within these families that we find social development at its height. Few in this section are classed as injurious, the exceptions being found principally among the ants.

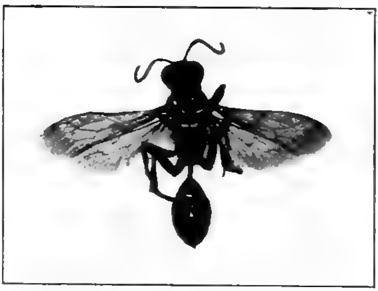

FIG. 40. — A wasp, *Sphecina*. Original.

The stinging Hymenoptera are divided into the following superfamilies:

Formicina, the ants. Many species with high social development.

Sphecina, the digger wasps. Solitary in their habits. A large group, including many families.

Vespina, the true wasps. One group is solitary and another social.

Apina, the bees. Various habits, but all collect pollen or honey to feed their young.

FIG. 41.—A bee, *Bombus*. Original.

The number of described species of Hymenoptera is in excess of 30,000.

CHAPTER VIII

How Insects Spread

The spread of insects is brought about by a great variety of agencies, some of which are within human control, while others are not. It is the purpose of this chapter to point out a few of the former as well as the latter, and to emphasize the value of taking precautions to prevent the spread of noxious species. With many serious pests an ounce of prevention is worth a good many pounds of cure.

Certainly the power of flight possessed by most insects is normally their principal means of dispersal to new feeding grounds. Unfortunately this is a matter usually quite beyond human control. Nevertheless, as will be seen later, there are barriers even to powers of flight, and some of our most injurious pests, which are capable also of sustained flight, would never have reached this country at all, or the section where they are now a menace, had it not been for other means of dispersal entirely within the control of man.

Strong winds, streams, ocean currents carrying débris or drift infested with insects, birds which are known occasionally to bear minute forms on their feet — all these are occasional means of the dispersal of insects and their introduction into new localities.

But if we were to reckon up the hundred pests that are working greatest havoc with our farms and orchards to-day, we should find that at least half of them, if not three fifths, had been introduced, directly or indirectly, through the agency of man himself.

The ways in which this comes about are many. When shrubs or trees are imported from foreign countries, they are likely to be infested with pests new to this continent. The insect thus imported is apt to get a foothold and to develop into a pest of the first magnitude. It was

in this way that the San José scale was brought to the United States, and similar circumstances made possible the introduction of the brown-tail moth.

Various substances used as packing for manufactured products imported from the far corners of the world may harbor threatening insects.

Fruits, fruit products, or other edibles imported for consumption in the United States may, and often do, introduce injurious species.

Undoubtedly the majority of the pests thus accidentally introduced fail to become established and never are heard from. But if only an occasional species gains a foothold and multiplies, the results are sufficiently disastrous.

Finally, it happens sometimes that living specimens are imported for experiment or study, and through accident are allowed to escape. The best-known example of this is found in the gypsy moth, now costing New England millions of dollars in attempted suppression or control.

CHAPTER IX

Insects as Carriers of Disease

Within comparatively recent years careful study has been given to insects as carriers of human disease, with the result that astounding facts have been disclosed. We know to-day that several of the serious and fatal diseases that afflict man, and several others to which domestic animals are subject, are carried or transmitted by insects; and in some cases the disease is carried in no other way. The study of these facts and possibilities constitutes the new Medical Entomology.

House Flies

Beyond doubt the commonest and the worst offender is the house fly. Both observed facts and careful experiments have proved that this insect is instrumental in the spread of typhoid fever, tuberculosis, and certain intestinal diseases, and there is every probability that further study will reveal others.

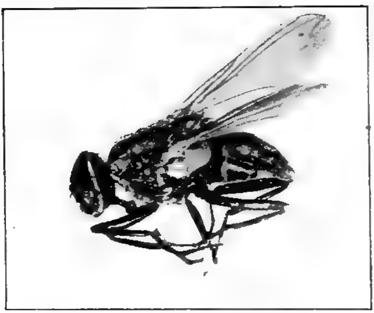

Fig. 42. — The House Fly, *Musca domestica* Linn. Enlarged. Original.

The habits of the fly in its choice of breeding places, its irrespressible tendency to enter our houses and walk over our food, and the structure of its body, especially its feet and its tongue, form the chain of circumstances by which the transfer of disease germs is brought about. The same fly that spent its larval life as a maggot in filth or infected excre-

ment later comes through our opened doors or unscreened windows, its hairy feet loaded with dangerous germs, and alights on the food set on our dinner table. Or, coming from the street, where it has been feeding on the sputum of some unfortunate victim of tuberculosis, it brings in the deadly bacteria in the ridges and hollows of its tongue.

Mosquitoes

In a wholly different manner the mosquitoes of certain species have been proved to transmit malarial fever. Indeed it is known that this disease never is transmitted in any other way. Here, in contrast to the fly which simply carries germs mechanically on some part of its body, we have an insect that serves as an intermediary host to the organism, the latter going through a definite part of its life round within the body of the insect, the remainder within the body of man. The mosquito itself is infected by sucking the blood of a human being suffering from malaria. The organism that causes the disease, being thus transferred to the stomach of the insect, goes through certain changes, and eventually collects in large numbers in the salivary gland of the mosquito. If, now, this insect bites another person, the organisms are transferred to the latter, and shortly develop in the blood, giving rise to the characteristic chills and fever, recurring at regular intervals, according to the particular type of organism with which the mosquito has been infected.

Fig. 43. — A malarial mosquito, *Anopheles maculipennis* Say. Enlarged and natural size. Original.

As a direct result of this knowledge it has been possible to bring about phenomenal results in fever-ridden districts, by careful screening, and by isolating fever patients so that mosquitoes could not get at them while they were suffering from the disease. In places where this

work has been carefully done the death rate from malaria has been reduced to a small fraction of that formerly prevailing.

Other Diseases Transmitted

Yellow fever is transmitted solely by certain species of mosquitoes. In Montana and Idaho a disease known as spotted fever is carried by a tick. The terribly fatal bubonic plague is transmitted largely by fleas. A species of fly has been found to be the means of spread of the sleeping sickness that has been ravaging some sections of Africa. Yet this is only a part of the known list.

Among domestic animals, a striking example is found in the disease known as Texas fever, which has caused tremendous losses among owners of cattle. The organism causing this disease is carried by a species of tick, and infection invariably takes place only through the bite of this tick. In Asia and Africa other serious or fatal diseases of domestic animals have been traced to insect carriers, and it is probable that similar discoveries will be made here.

CHAPTER X

The Natural Enemies of Insects

That insects have a host of natural enemies which constantly prey on them is as certain as the fact that insects exist at all. If it were not so, and if our pests reached the full limit of their powers of increase unchecked, there would shortly be no living plant left on the face of the earth, and no trace of animal life. Insects possess preëminently the ability to multiply rapidly and to spread widely. Thus it has been computed that the progeny of one plant louse in a single season, if allowed to multiply at the maximum rate and if none suffered accidental death, would make a mass of matter equal in weight to that of the earth.

Fig. 44. — Protective coloration. Butterflies among dead leaves. Original.

Fig. 45. — Protective resemblance. Moth on the trunk of a tree. Original.

Birds and Other Animals

Among the higher animals that destroy noxious insects birds are entitled undoubtedly to first rank. Few of us appreciate their services.

Scores of species depend largely on insects for their food during a part of the year, if not throughout all of it. Among our best friends are the swallows, chickadees, cuckoos, the kingbird, catbird, robin, bluebird, and the woodpeckers; but this list is merely suggestive.

Birds are peculiarly fitted for dealing with outbreaks of injurious insects. Possessed of the power of flight they can flock to places where insect pests that they enjoy are in abundance. At the same time they are not bound to maintain a species at reasonable abundance in order to protect their source of food and keep it from disappearing entirely, as is the case with many insect parasites.

Toads are entitled to prominent rank as destroyers of insects. The number of specimens consumed by them in a season is enormous. Other animals that live on insects to a considerable extent are skunks, moles, and field mice.

Efficient enemies of aquatic insects, or of such as spend part of their life beneath the water, are various species of fishes.

Predaceous and Parasitic Insects

The greatest inroads in the ranks of injurious insects are made by other members of the same great class itself, by the predaceous and parasitic insects.

In general, we speak of predaceous insects as those that attack and feed on other insects or animals of various species, but are not dependent on a single individual host for their existence. Thus

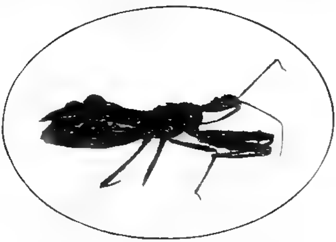

Fig. 46. — A predaceous bug, *Sinea diadema* Fab. Original.

Fig. 47. — Adult Braconid. An egg parasite. Enlarged and natural size. Original.

Fig. 48. — Larva, showing exit holes of parasites. Original.

the dragon fly, poised in air and waiting to pounce on some unwary gnat or fly, is predaceous.

A parasitic insect, on the other hand, usually is highly specialized for existence on some particular species of host, and has reached such dependence on its host that if the latter dies before the parasite has completed

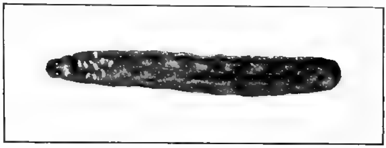

Fig. 49. — Eggs of a parasite on a cutworm. Original.

its life round, the parasite perishes. Many parasitic insects live within the bodies of their hosts. A familiar example is found in the species that lays its eggs in the body of the tomato worm, the parasitic grubs finally gnawing their way to the surface, where they spin tiny, white cocoons on the body of their host.

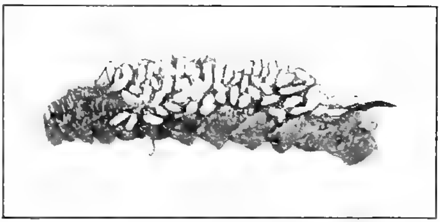

Fig. 50. — Cocoons of parasites on a larva. Original.

For most of us, the tremendous work of parasitic and predaceous species in destroying insect pests passes unnoticed. It is brought to mind when we see or hear of a bad outbreak of some injurious insect, and later observe that the threatening species has suddenly grown scarce — sometimes seemingly disappeared from the face of the earth in the very localities where it had been abundant. If we were to follow up such cases carefully, we should find, as a rule, that as soon as the threatening species

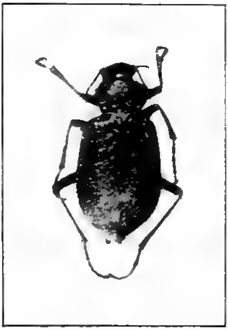

Fig. 51. — Predaceous beetle, *Calosoma*. Original.

began to grow excessively numerous, some one of its enemies, stimulated by the abundance of food, increased so rapidly that with the next generation or the next season the injurious species was well-nigh wiped out of existence.

In truth, there is a sort of natural balance between the numbers of a given species of insect and those of its enemies. If the insect increases abnormally, the parasites are stimulated to heavy increase and the numbers of the host are rapidly diminished. If, on the other hand, the host decreases abnormally, the parasites perish from lack of food, and thus, freed temporarily from their attack, the host is enabled to increase once more.

Consideration of the above law helps greatly to explain the fact that injurious species imported from a foreign country are so often intolerable pests. We have brought over the host without its enemies. Finding conditions here congenial, it multiplies to excessive numbers, escaping the attack of the parasites that would have taken it in hand in its native home.

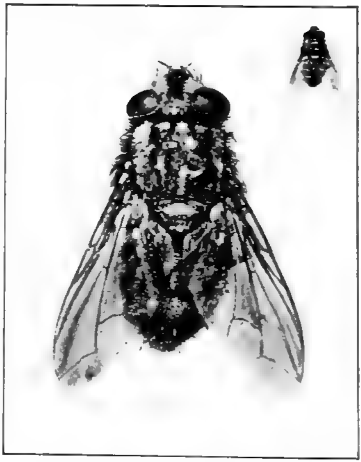

Fig. 52. — Adult tachina fly; enlarged and natural size. The larvæ are parasites. Original.

Occasionally, it has been found possible to import artificially the parasites of an introduced pest, and to establish them successfully in this country. But the venture is tedious and exceedingly difficult. Some condition of weather or tempera-

ture is found unfavorable to an essential parasite; or it is discovered that in its new home the parasite itself is attacked by some enemy from which it was free in its native land. Rarely, however, the experiment is successful; and the few instances that do work out satisfactorily abundantly repay for the labor and cost of all.

The most extensive attempt at the introduction of parasitic and predaceous enemies from abroad for the control of a menacing pest is that now in progress, under the auspices of the Bureau of Entomology of the United States Department of Agriculture, in the fight against the gypsy moth. At least ten or twelve species must be collected, imported, and colonized successfully, in order to make this work a complete success; but there is excellent prospect of ultimate accomplishment; and meanwhile, no other known measures will avail to limit the ravages of the pest.

FIG. 53. — Eggs of *Chrysopa* sp. Predaceous on plant lice. Enlarged. Original.

Among our valuable families of predaceous insects are the ground beetles, tiger beetles, and lady-bird beetles in the order Coleoptera; the assassin bugs and many aquatic forms in the order Hemiptera; the dragon flies constituting the order Odonata; and several families in the two-winged flies or Diptera.

Two orders furnish the majority of our parasitic species, the Diptera and the Hymenoptera. The number of parasites within these orders is enormous. The principal families include the Tachina flies and the Syrphus flies in the Diptera, and the Ichneumons, Braconids, and Chalcids in the Hymenoptera.

Fungous and Bacterial Diseases of Insects

Fungous diseases of various kinds attack insects, and occasionally are responsible for their death in large numbers. A familiar example is seen at the close of every summer when many of our common house flies may be observed clinging to the ceiling, their abdomens distended and covered with a fine, powdery substance, while a ring of the same light powder surrounds the insect's body on the ceiling.

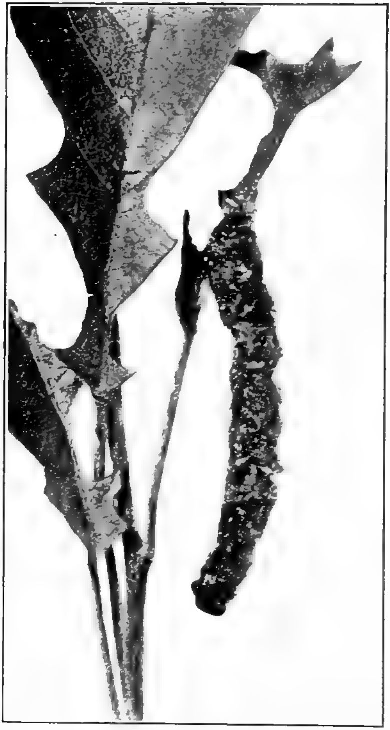

Fig. 54. — Tent Caterpillar, *Malacosoma americana* Fab., killed by a fungous disease. Original.

Nearly every season specimens of the common tent caterpillar may be found hanging from a leaf or twig, the body misshapen and covered with a powdery growth. Millions of brown tail caterpillars have been killed in the New England states in the last two years by a fungous disease.

Attempts have been made to propagate these diseases artificially. A fair measure of success has sometimes attended these efforts, but the undertaking is difficult, owing to the fact that certain conditions of weather and moisture appear to be essential to the growth of the fungus.

Caterpillars of some species are attacked also by bacteria of one or

more species. Thus, the gypsy caterpillar occasionally dies off in large numbers from the effect of a disease due to a species of such

FIG. 55. — Tent Caterpillars killed by a disease caused by a species of bacteria. Original.

organism. The same or a similar disease attacks also the common tent caterpillar.

PART II

THE METHODS OF INSECT CONTROL

CHAPTER XI

Farm Practice in Relation to Insect Control

To a considerable extent, — more than most of us suspect, — the depredations of injurious insects in our fields, orchards, and gardens may be reduced or controlled by the farm practice followed on a given place; methods of tillage, crop rotations, and such matters as thoroughness in eradicating weeds. More emphasis should be laid on the fact that all farm matters, including the tax paid to insect pests, are largely interdependent; that careful consideration given to the subject of probable insect attack when planning the procedure for a season or a series of seasons invariably will pay, and pay well.

Crop Rotation

Of these various matters, crop rotation is one of the most important. An example will illustrate the point.

Many insects attack only one kind of plant; say corn, for example, or strawberries, or onions. It may always be expected that a few such pests will find their way to a field that has been planted to some one of these crops. If not very abundant, they may, and probably will, pass entirely unnoticed, and the injury that they do will be so slight that it may properly be disregarded.

Now, many or most of these insects spend the winter close by the scene of their summer's feeding; in the ground, under rubbish, or elsewhere near at hand. Assume now that this field is planted to the same crop the succeeding season. It will start out with an abundance of insect enemies, especially adapted to that crop. Instead of an injury so small that it passes unnoticed we may have a disastrous attack.

Again it is well to avoid planting in the same field in successive seasons crops that are closely related botanically. Some of our in-

jurious species attack not simply a single variety of plant, but any that comes within the same group, — for example, the striped cucumber beetle, which will feed impartially on melons, squashes, and cucumbers.

It should be noted in passing that the plan that is good practice from the standpoint of avoiding insect attack is likewise the procedure recognized as wisest in maintaining the fertility of the soil and avoiding difficulties on other scores.

Special Questions in Crop Rotations

Even where unlike crops follow one another, it may be wise to alter the program because of threatening insects left by one crop for the next in the rotation. To illustrate: when a field has been in sod for a number of years, it is apt to harbor large numbers of wireworms. This is due to the fact that sod ground forms the natural breeding place of this insect. The presence of the wireworms might not be suspected, for the grass roots on which they feed are so numerous in the soil that no appreciable damage would be done to the sod. But, break up this sod, so that the grass roots are killed, and plant the field to potatoes. The wireworms will still be there in considerable numbers, since they normally spend two or three years in the larval stage. In the whole field there will be left for them to feed on nothing but the seed potatoes that the owner has placed in the ground. The result, if the field was well infested, will be a wholsesale destruction of the seed potatoes, and if the owner replants, a repetition of the same performance. Had the field been planted to clover, or some other similar crop in the family of legumes, there would have been little or no injury.

Fall Plowing

Deep fall plowing is of value in destroying many forms of soil-inhabiting insects — as well as helping to form a good seed bed and conserve soil moisture. It is the habit of several pests of field and garden crops to spend the winter as pupæ or adults in the soil, sometimes in little earthen cells. Deep plowing, late in the fall, disturbs these and throws many of them up to the surface of the ground.

Removing Crop Remnants

Other insects have the habit of hiding away under rubbish or crop remnants, such as old potato vines or cabbage stumps. It pays to remove these as soon as the crop is off. The vegetable matter that they represent need not be lost if they are piled up in some odd corner and allowed to rot, so as to form humus which later may be used where desired.

Destruction of Weeds

Weeds are a genuine nuisance in the matter of encouraging noxious insects. It is common for a pest that feeds on a given variety of plant to make use of some closely related weed as its source of food until the cultivated crop is ready for attack. Some of our garden insects habitually thus eke out an existence in the early spring or late fall. In the case of other species it is the habit of the pest to go through its first generation of the season on a weed, a second generation coming forth in irresistible numbers as the time arrives for the cultivated crop to put in its appearance.

Changing Time of Planting or Harvest

Sometimes, as in the districts where wheat is attacked by Hessian fly, there is advantage to be gained by changing the time of planting. With the Hessian fly it is the aim of the grower to defer the planting of winter wheat for a few days beyond the customary time, so that the plants will not be large enough to serve the purposes of the fly when it comes out later to lay its eggs. On farms where this procedure is followed carefully and accurately, injury from this pest has largely been avoided. With other insects similar variations in farm practice have been worked out, wherever the habits of the pest make such a remedy possible.

The Value of Poultry

Countless numbers of insects are picked up by poultry when allowed to range over considerable area, as is especially the case where the colony system of housing is followed. Not only are troublesome

pests thus destroyed, but the fowls themselves obtain a fair share of their living.

In orchards several serious pests transform or hibernate in the soil, or hide away under weeds and in clumps of grass. An example is the plum curculio. Fowls will secure many of these. In the fields chickens will readily follow a plow, and will find many specimens that live in the soil, such as white grubs and wireworms. Bugs and caterpillars in grains and grasses are destroyed by the wholesale.

Stimulating Plant Growth

Where it is not possible to prevent the attack of an insect, it often is feasible so to stimulate plant growth that the injury will not prove disastrous. Or, to put it the other way, crops that are kept growing vigorously and are fed liberally are able to withstand insect attack, and to make a good yield in spite of it. Since we cannot always predict what pests will be prevalent in a given year, the wisdom and the advantage of maintaining vigorous and healthy growth by all practicable means is apparent. The fact is again here emphasized that whatever constitutes good farm practice in one regard is apt to help out as well in others.

CHAPTER XII

Direct Control by Mechanical Means

Some of the important measures for the control of injurious insects have been discussed in the preceding chapter. For the most part these may be classed as indirect methods, since they are intended largely to prevent attack or injury, and are a part of general farm practices adopted for various reasons besides those relating to insects.

On the other hand there are measures that are intended directly to accomplish the destruction of a given pest or to prevent its attack, and are adopted primarily for that purpose.

First among these are a number of simple methods that naturally suggest themselves in the case of the larger insects or those that congregate in limited areas; such as hand picking or burning. Measures of this kind require no special apparatus, and often are effective. They may or may not presuppose accurate knowledge of the life history or habits of the insect dealt with; but often such knowledge is essential if any real benefits are to be secured.

Examples of this type are as follows:

Hand Picking

Hand picking, jarring, or brushing is a common practice in dealing with such insects as the tomato worm, squash bugs, and the like. It is worth knowing that a mass of such insects collected in a box or other receptacle can easily be killed by sprinkling them with kerosene.

Burning

Burning is often a prompt and effective remedy, especially with caterpillars that tend to congregate in masses. A familiar example is seen in the common tent caterpillar.

A simple torch is conveniently made by tying a ball of rags tightly on the end of a pole, and soaking with kerosene, taking care not to use so much of the liquid that it runs down the pole.

Destroying Egg Masses

Destruction of egg masses is a valuable means of control where the egg clusters may be found readily. Egg masses may be crushed, or they may be painted with some penetrating oil, such as creosote.

Banding

In the control of some caterpillars, banding the trees is simple and effective: but it is absolutely worthless against others. Its value depends on the characteristics of the insect to be dealt with. Thus, in the case of the cankerworm infesting apple trees, the adult female happens to be wingless, and must crawl up the trunk to lay her eggs. A sticky band will stop her from going up to the branches, and if the band is maintained until the young worms have hatched and they in turn are thus prevented from ascending the tree, no damage can be done to the foliage. But this band would be useless as a means of preventing a winged moth, such as the parent of the tent caterpillar, from gaining access to the tree. Bands are of value also where it is desired to prevent caterpillars that have hatched on adjacent land from migrating to trees that had been protected or cared for.

An effective substance for banding is the material known as tree tanglefoot. It cannot be made at home, but must be bought ready prepared. Printer's ink is dangerous if applied directly to trees with tender bark. It may be smeared on a sheet of paper tied around the tree.

Covering with Cloth or Screen

Usually this plan is made use of to prevent injury to young plants, until they have grown large enough to withstand attack. Young melon or squash plants are thus protected from injury by the striped cucumber beetle.

Where cloth is used, it should be of thin texture. Common cheese-

cloth serves the purpose very well. Handy covers are made by cutting a barrel hoop into two pieces, crossing these at a right angle, tacking the ends to a second hoop, and covering this frame with cloth. Such frames may be packed away for storage, one within another, taking up little room.

Wire screening may be shaped into cones, which are used in the same way as the cloth-covered frames, and have a similar advantage of packing away in small space. If galvanized wire is used and properly stored when not needed, it will not rust for several years; but the first cost is rather heavy as compared with cheesecloth frames.

Destroying Borers

Cutting out borers with a knife is a remedy that seems drastic, but it may be the only means of putting a stop to an injury that would otherwise prove fatal.

Frequently, it is possible to kill the borer by probing the burrow with a soft copper wire. If the end of the wire is nicked, so as to give it a few rough barbs, it will bring the borer or a piece of him out with it, and the operator may thus know whether he has succeeded in reaching the culprit.

If cutting is necessary, a sharp knife should be used and the course of the burrow carefully followed. In this way no more real damage will be done to the tree than has already been done by the borer itself. It is well to paint the wound afterward with a mixture of lead and linseed oil — not with ready-mixed paint, which is apt to contain injurious oils added as driers.

Removal of Dead or Dying Limbs

There are certain species of small borers that attack especially trees that have been weakened. Once started, they continue to breed in such places, rapidly killing the tree and spreading from it to others in the neighborhood that do not happen to be growing as vigorously as might be. By prompt removal of the infested limbs or trees the pests may be eliminated and other trees near by saved from attack. This, in fact, is the only feasible means of control in the case of some insects,

such as the shot-hole borer. The limbs or trees removed should be converted at once into cordwood and burned. Otherwise, little will be gained by their removal.

Use of Traps

The kinds of traps are legion, and range all the way from chips or stones placed in the garden for squash bugs to hide under to more or less ingenious devices for capturing roaches and flies. Many are efficient, though it often seems that new individuals make their appearance about as fast as the others are caught. At best the total numbers merely are reduced.

A variation of traps is seen in the use of *trap crops.* By this device some kind of plant is introduced that the pest is fond of, and after the insects have collected on these plants, they are destroyed by poisoning, burning, or by spraying them with some oil or corrosive, such as pure kerosene. In other cases the trap precedes the regular crop, and thus diverts attack from the more valuable plant. Thus, early kale is sown in fields that later are to be set out to cabbages, in order to attract the overwintering adults of the harlequin cabbage bug.

CHAPTER XIII

Insecticides — General Principles

The use of chemicals for the destruction of insect pests had its origin with the advent of the Colorado potato beetle in our fields, about 1870.

The beetle first came to notice as a pest of cultivated potatoes in the region between the Mississippi River and the Rocky Mountains. It spread steadily eastward, and in a few years reached the Atlantic coast. It was feared at the time that the growing of potatoes was doomed, and famine was freely predicted.

Then came the suggestion that the potato tops be dusted or sprayed with Paris green, so as to poison the pest. The remedy was found to work. And thus was started the modern practice of using chemicals for the control of injurious insects.

To-day a large proportion of our insect pests, more especially those infesting garden truck, fruits, and stored products, are controlled by some form of spraying, or by fumigation.

The primary rule governing the application of chemicals for the control of an injurious insect is to determine the feeding habits. If the pest is one that eats the foliage or tissues, in other words, if it has biting mouth parts, it may usually be killed by applying to the plant some form of stomach poison, such as Paris green or lead arsenate. If, on the other hand, the pest sucks the plant juices instead of chewing or eating the tissues, in other words, if it has sucking mouth parts, it is utterly useless to apply any of the stomach poisons to the surface of the plant, for they will not be taken up by the insect. The sucking beak, thrust down through the surface of the leaf, misses the poison. In this class of insects, therefore, the chemicals applied must be such as will kill the insect by contact with it, usually by entering its breathing pores.

In other words, *poison* sprays for leaf-eating insects are applied to the *plant*, to be eaten along with part of the plant. *Contact* sprays are applied to the *insect*, and only incidentally to the plant, since we could not hit the one without hitting the other. With these, the great aim is to apply the material so thoroughly that it will certainly come into contact with all the insects concerned.

A third method of using chemicals is to take advantage of the suffocating qualities of certain gases. Such materials are known as *fumigants*. They are of great value in fighting pests living in stored products, such as the grain weevils. It is necessary, in using fumigants, that the materials treated shall be in a closed receptacle.

An anomalous material, applied frequently in the open air but killing the insect by the volatile oil that it gives off, is the so-called Persian insect powder.

Examples of insects that have biting mouth parts and are killed by poison sprays are the grasshoppers, roaches, beetles, and practically all caterpillars.

Examples of insects that have sucking mouth parts, and cannot be killed by poisons, but must be fought with contact sprays or by some other means, are the thrips, fleas, and the true "bugs" — such as the squash bug, plant lice, scale insects, and leaf hoppers.

CHAPTER XIV

Poison Insecticides — For Biting Insects

Paris Green

Paris green	5 ounces
Lump lime	1 pound
Water	50 gallons

For small quantities use:

Paris green	1 heaping teaspoonful
Lump lime	2 or 3 ounces
Water	3 gallons

Paris green is a bright green, heavy, finely divided powder, and is one of the compounds of arsenic. It may be applied dry, but is much better used in water or other liquid as a spray. It is a violent poison. The present standard calls for at least 50 per cent arsenious oxid, and not over 3½ per cent soluble arsenic.

If applied dry, mix with three or four times the same weight of flour or fine, air-slaked lime, preferably the latter. Dust lightly on the plants. Be careful not to put on too much, or there will be danger of burning the foliage because of the "free" or soluble arsenic apt to be found in the material. A good way is to mix the poison and the lime together, thoroughly, place in a muslin bag and shake gently over the plants. If this is done when the dew is on, or just after a shower, the material will stick better to the foliage.

If to be used as a spray, Paris green may be mixed with water or with Bordeaux mixture. In either case, the amount to use is from 4 to 5 ounces of the Paris green to 50 gallons of the liquid. If water is used, add about 1 pound of fresh lump lime to each 50 gallons of water. This is done to neutralize any soluble arsenic present and thus avoid injuring the foliage.

Resin soap is sometimes added to a solution of Paris green and water, in order to make the material stick to smooth leaves. It may be bought in stores, and should be used at the rate of 3 pounds to 50 gallons.

Resin-lime mixture, especially adapted for the purpose of a "sticker," is made by heating in an iron kettle 1 gallon of water, 1 pint of fish oil or other animal oil, and 5 pounds of resin. Then add lye solution, prepared by dissolving one can of lye according to the directions on the can. After thorough stirring, add hot water to make 5 gallons, and boil two hours, adding water to make up that lost by boiling. The resulting liquid is light brown and clear and will unite smoothly with cold water. For use take 3 gallons to 50 gallons of water, then add 3 gallons of thick whitewash, and finally add the Paris green.

Advantages of Paris green are its cheapness, its quick action in killing insects, and the fact that it may readily be obtained in most stores. Disadvantages are its liability to adulteration, the fact that it settles quickly in the spray barrel, that it sometimes burns the foliage, and that it is rather easily washed off by rains. The last-named fact is an advantage, rather than a disadvantage, if it is desired to spray plants that will soon be ready for use, and will therefore need to be washed clean.

Arsenate of Lead

Arsenate of lead (paste)	3 to 10 pounds
Water	50 gallons

or

Arsenate of lead (powder)	1 to 4 pounds
Water	50 gallons

For small quantities use:

Arsenate of lead (paste)	1 tablespoonful
Water	1 gallon

Arsenate of lead is obtainable in two forms: a thick, light-colored paste, or a white powder. The former is more commonly the manner in which it is put up. The two do not differ chemically. Arsenate of

lead is a compound of arsenic, but is a less violent poison than Paris green. The standard requirements for the paste call for at least $12\frac{1}{2}$ per cent arsenic oxid, not over $\frac{3}{4}$ per cent soluble arsenic, and not over 50 per cent water.

To apply as a spray, the paste may be mixed with water, with Bordeaux mixture, or with lime-sulphur solution. In either case the strength to employ is from 3 to 10 pounds of the paste in 50 gallons of water, or of Bordeaux mixture, or of lime-sulphur solution.

If the dry lead arsenate is used in making up a spray, it is advantageous to employ the finely powdered form made by the "electro" process. The proportions will be from 1 to 4 pounds of the powder to 50 gallons.

Either the paste or the powder should first be mixed with a little water, so as to get it into a thin paste. It is entirely unnecessary to add lime.

Owing to the fact that arsenate of lead is not as violent a poison as Paris green, it is necessary to use heavier doses for larger or resistant insects, as indicated in the formula given above.

Powdered arsenate of lead, applied dry, is developing a special field of usefulness and promises to become a valuable form of insecticide application. Paris green has been used in this way for many years, especially on some truck and field crops in the South; but it is rather likely to burn the foliage and is easily washed off by rains. Powdered lead arsenate, especially the amorphous form made by the so-called "electro" process, rarely will burn the plants, and if applied after a shower or when the dew is on the leaves, it sticks tightly.

On most truck crops or field crops it has important advantages over liquid applications. The apparatus for applying it is light and inexpensive; large areas can be covered easily and rapidly; the need of drawing a heavy cart through the field is obviated; and if a good powder gun is used, the material can be forced in large quantities into the places where it will do the most good. It is not suitable for orchard work in general, or for work of such character as vineyard spraying.

Advantages of lead arsenate are the facts that it will not usually burn foliage, that it stays in suspension in the spray mixture fairly

well if moderately agitated, and that it is not easily washed off the leaf surface. Disadvantages are its larger cost and the fact that it does not so quickly kill insects as does Paris green.

Hellebore

Hellebore	1 ounce
Water	1 gallon
or	
Hellebore	1 part
Flour	3 parts

Hellebore is a white powder, consisting of the finely ground roots of the plant known as white hellebore (*veratrum album*). It is of little value unless it is fresh, or has been kept in a tightly closed vessel. It is poisonous to the larger animals when taken in sufficient quantity.

It may be used dry or as a spray. If it is to be used dry, mix it with flour at the rate of one pound of the powder to three pounds of flour, and let the material stand over night in a closed vessel. It may then be dusted on the plants in any convenient manner. There is no danger of burning the foliage. If to be used as a spray, steep one ounce of the powder in one gallon of water.

Hellebore has the advantage that it loses its poisonous properties after exposure to the air for three or four days, and therefore may be applied with safety to ripening fruits; for example, currants that are about ready to use.

Poison Bran Mash

Bran	25 pounds
Paris green	½ pound
Cheap molasses	1 quart

Water as needed to moisten.

For small quantities use:

Bran	1 quart
Paris green	1 teaspoonful
Cheap molasses	1 tablespoonful

Water as needed to moisten.

Poison bran mash is a mixture of Paris green, bran, and sweetened water, and is used particularly for cutworms.

Mix, dry, $\frac{1}{2}$ pound of Paris green and 25 pounds of bran. Middlings or meal may be used instead of bran, but the latter is to be preferred. Prepare some sweetened water, by mixing 1 quart of cheap molasses and 2 gallons of water. Moisten the poisoned bran with this sweetened water, using additional water if necessary so as to get the bran thoroughly moist throughout, but not so wet as to be sloppy. The poison mash thus obtained is scattered on the surface of the ground.

CHAPTER XV

Contact Insecticides — For Sucking Insects

Lime-sulphur Solution

Lime sulphur is a chemical combination of lime and sulphur, and kills insects by its caustic properties. At the same time it has considerable value as a fungicide, for the control of such plant diseases as apple scab.

The material is used both as a winter spray, when the trees are dormant, and as a summer spray, the latter for fungus diseases; but the solution for summer use is much weaker. Material of the proper strength for winter use must never be sprayed on trees in leaf as it will burn the foliage.

The best time to apply the winter strength of lime-sulphur solution is in the early spring, just before the buds swell. For San José scale and for leaf blister mite, two insects for which this material is especially useful, this is the most effective season. It may be applied in the fall, however, at any time after the leaves drop.

There are three ways of preparing the winter wash of lime sulphur: by diluting the commercial concentrated solution now on sale in stores to the required strength; by making a concentrated solution at home, and properly diluting when needed; and by making at home a solution which when finished is ready at once for use. These will be described in order.

Commercial Lime Sulphur

Commercial concentrated lime sulphur is a clear, reddish brown liquid. It has been placed on the market by a number of manufacturers, and is obtainable practically everywhere.

For use, this material simply is diluted with water. The amount of water to be added always is indicated on the container in which the liquid comes. But if it is desired to test the strength, this can be done

with a hydrometer, which will indicate the specific gravity. Procure a hydrometer marked according to the Baumé scale, and dilute according to the table given below in the directions for diluting home-made concentrated lime sulphur, remembering that this is for use on dormant trees only.

Since this spray material is quite clear, it shows but little on the trees. Some operators, therefore, are following the practice of adding lime to the material after it is diluted ready for the spray tank, in order to make the spray show up. Probably there is no advantage gained in efficiency, but one can tell whether the tree is thoroughly coated. The lime must be added after the material is diluted. Either lump lime or air-slaked lime, at the rate of 6 or 8 pounds to 50 gallons of diluted spray, may be employed. It will require about ten minutes for the lump lime to slake. Care should be taken to arrange matters so that the addition of lime will take place before the final straining.

Home-made Concentrated Lime Sulphur

Lump lime	50 pounds
Sulphur	100 pounds
Water (hot)	70 gallons

Dilute as directed.

If suitable appliances are at hand, it is feasible to make up concentrated lime sulphur at home, which can be diluted for use when needed. It is absolutely necessary, however, to keep the finished product sealed up away from contact with air, and it is essential that the purity of the materials used be guaranteed. In most cases, it will be found that the commercial concentrate is safer.

To prepare the concentrate, have ready two boilers, one of which must be of 100 gallons capacity and is used for boiling the materials, while the other serves to keep ready a supply of boiling water to replenish the material as it boils down. It is advisable to have a measuring stick, so that the amount of liquid may be ascertained from time to time, and hot water added when needed. It is much better if the cooking can be done by steam, in a closed vessel; but direct fire will do.

Place in the main boiler 50 pounds of stone lime. Add 20 gallons of hot water. While the lime is slaking add 100 pounds of sulphur. Stir the mixture thoroughly and constantly, adding more water from time to time. When the lime is slaked, add hot water to make 70 gallons. Boil this slowly for one half to three quarters of an hour, or until all of the sulphur and lime are dissolved. Dip out small quantities and test from time to time. As the material boils away, add hot water to keep the volume up to 70 gallons. When the materials are all dissolved, pour out into barrels, straining carefully, and allow to cool. At once close up as nearly air tight as possible.

To dilute for use as a winter spray, take 1 gallon of the concentrate to 5 gallons of water. Or, better, have a Baumé hydrometer, test the specific gravity of the concentrate, and dilute with water according to the following table:

Reading on Hydrometer in Degrees Baumé	Number of Gallons of Water to One Gallon of the Concentrate
35	9
34	$8\frac{3}{4}$
33	$8\frac{1}{4}$
32	8
31	$7\frac{1}{2}$
30	$7\frac{1}{4}$
29	$6\frac{3}{4}$
28	$6\frac{1}{2}$
27	6
26	$5\frac{3}{4}$
25	$5\frac{1}{4}$
24	5
23	$4\frac{1}{2}$
22	$4\frac{1}{4}$
21	$3\frac{3}{4}$
20	$3\frac{1}{2}$
19	$3\frac{1}{4}$
18	3
17	$2\frac{3}{4}$
16	$2\frac{1}{2}$
15	$2\frac{1}{4}$
14	2

The above dilutions are for *winter strength* (the material commonly used for San José scale and leaf blister mite).

Regular Home-made Lime-sulphur Wash

Lump lime	20 pounds
Sulphur	15 pounds
Water	50 gallons

The material here described, when finished, is of the proper strength for use as a winter spray, without further dilution. It contains much sediment, and must always be carefully strained before use, or it will clog the nozzles intolerably. It is the standard formula with many fruit growers, and is considered to be especially effective against San José scale.

It is easier to prepare it if facilities are at hand for cooking by steam; but the use of large iron kettles is permissible, provided the material is stirred constantly and vigorously during the entire time it is cooking.

Place in the boiler 20 pounds of stone lime. Add a few gallons of hot water to start the lime to slaking, and then gradually add 15 pounds of flowers of sulphur, stirring constantly. Add 12 gallons of hot water, and boil hard for an hour. Dilute with more hot water until there are 50 gallons of the mixture. Strain carefully, using preferably a brass wire strainer with twenty meshes to the inch. Apply the solution while still hot.

Kerosene Emulsion

Hard soap	½ pound
Hot water (soft)	1 gallon
Kerosene (coal oil)	2 gallons

Dilute as directed.

Kerosene emulsion is a valuable insecticide, especially for destroying hibernating insects in rubbish, and, when further diluted, for killing plant lice, and other similar insects. The ingredients are kerosene (coal oil), soap, and water. By means of the soap the oil is broken up into extremely fine particles, or, in other words, is "emulsified," so that in effect it may be applied greatly diluted, and its killing power on insects secured without injuring plant tissues.

To prepare, shave up ½ pound of laundry soap in 1 gallon of soft

water. Have the water boiling hot. As soon as the soap is all dissolved, remove the solution from the fire and add 2 gallons of kerosene. At once agitate the material violently. This is best accomplished by the use of a bucket pump, turning the nozzle back into the bucket, so that the material is constantly passed through the pump. In a few minutes a smooth, creamy emulsion is formed, without any free oil. This will become thicker as it cools, but if it is properly made, no oil will separate out. This is the stock material, and will keep well, if sealed from air.

For use on trees or shrubs that are dormant it is customary to dilute the stock emulsion with 5 to 7 parts of water. On trees or plants in leaf dilute with 10 to 15 parts of water, depending on the type of insect and the kind of foliage. Soft-bodied insects such as plant lice are easily killed by a dilution containing only 5 or 6 per cent of oil.

To get exact dilutions use the following table:

For 4% strength add 15⅔ gallons of water to 1 gallon of stock solution.
For 5% strength add 12⅓ gallons of water to 1 gallon of stock solution.
For 7% strength add 8½ gallons of water to 1 gallon of stock solution.
For 10% strength add 5⅔ gallons of water to 1 gallon of stock solution.
For 12% strength add 4½ gallons of water to 1 gallon of stock solution.
For 15% strength add 3½ gallons of water to 1 gallon of stock solution.
For 18% strength add 2⅔ gallons of water to 1 gallon of stock solution.
For 20% strength add 2⅓ gallons of water to 1 gallon of stock solution.
For 25% strength add 1⅔ gallons of water to 1 gallon of stock solution.

Oil sprays are best applied on a sunny day when the wind is blowing, since surplus oil will then evaporate more quickly and there will be less danger of injuring the plant.

Crude oils are emulsified in the same way as kerosene. For certain insects, as indicated later, this spray is effective and desirable.

Linseed Oil Emulsion

Hard soap	1 pound
Hot water (soft)	1 gallon
Linseed oil (raw)	2 gallons

Dilute as directed.

The manner of making linseed oil emulsion is similar to that of making kerosene emulsion. The material has a special use in fighting oyster shell scale.

To make the stock emulsion take 1 pound of soap, shave up fine, and dissolve in 1 gallon of boiling soft water. When the soap is all dissolved, remove the solution from the fire and add at once 2 gallons of raw linseed oil. Churn the mixture violently by pumping it back on itself with a bucket pump. After a few minutes, a yellowish, smooth, creamy emulsion will be formed. No oil should separate out, if the stock is properly prepared.

To prepare for use, take 1 gallon of the stock and dilute with 9 gallons of soft water. This is for use on trees not yet in leaf. For oyster shell scale it is best applied just before the buds swell in the spring.

Commercial Tobacco Extract

Highly concentrated extracts of tobacco are now on the market, and constitute a valuable class of contact insecticides. They are dark-colored liquids, and are prepared for use by diluting with water, according to the degree of concentration of the brand purchased and the kind of insect concerned. It is advantageous to add soap to the solution, in order to make it spread more readily and prevent it from collecting in globules. Use 1 pound of soap to 50 gallons of the diluted spray.

Rather strong dilutions of commercial tobacco extract have been found of possible value as winter sprays to kill the overwintering eggs of certain plant lice on the bark or twigs of dormant trees.

Weaker dilutions are standard remedies for fighting various soft-bodied sucking insects, such as plant lice, thrips, and the like. These dilutions are applied with perfect safety to trees in leaf.

Similar dilutions are used as dips for sheep or other domestic animals, to kill mites and lice.

"Black Leaf 40," containing 40 per cent nicotine sulphate, is used for winter spraying, as noted above, at dilutions ranging from 1 part to 300 of water down to 1 part to 600. For use in summer the dilu-

tions range from 1 part to 500 in the case of resistant insects down to 1 part to 1000 in the case of tender plant lice. The dilutions for killing lice and mites on animals are similar to the last named. The strength of 1 to 500 should be used only as a wash and not as a dip, when treating pests on animals.

"Sulphate of Nicotine" is a preparation of similar strength, and the dilutions are the same.

Liquid "Nico-Fume" contains 40 per cent free nicotine, but the dilutions and manner of use are similar to the above.

"Black Leaf Extract" contains a much lower percentage of nicotine, and less water is added to it than to the others named.

Home-made Tobacco Extract

If tobacco stems or tobacco dust are available, an extract may be made at home. To prepare, pack the stems in a pail or kettle and cover with water. Allow to stand over night. Or, boil 1 pound of dust or stems in 1 gallon of water. An hour's boiling is sufficient. Dilute the extract with 1 to 2 parts of water. This material may safely be applied to plants in leaf and is effective against plant lice. Add soap at the rate of 1 pound to 50 gallons of spray. It is not advisable to employ this as a winter spray to kill the eggs of plant lice because the percentage of nicotine present may not be sufficient.

Insect Powder

Insect powder	1 ounce
Water	2 gallons

This is the material variously known as pyrethrum, buhach, or Persian insect powder. It consists of the finely ground flower buds of a plant. The active principle is volatile; hence the material rapidly loses its strength on exposure to air. It must be fresh, or must have been kept in a closed receptacle, to be effective.

Commonly it is used dry. Small powder guns are obtainable for applying it.

To use it as a spray, mix 1 ounce in 2 gallons of water. If it is

desired to use it in larger quantities, a convenient method is to steep 1 pound in 1 gallon of alcohol, then dilute with 40 gallons of water.

This material is not poisonous to man or the higher animals.

Soap Solution

Hard soap	1 pound
Water	5 gallons

A simple solution of soap and water is effective against plant lice and similar sucking insects, and is especially useful for treating insects infesting house plants, where it is not desirable to use other and less pleasant materials.

Ordinary laundry soap may be used. Dissolve 1 pound of soap in 5 gallons of water. This solution will not injure plants in leaf.

Whale-oil soap may be used instead of laundry soap. The potash soap is best. It should contain not over 30 per cent water. One pound in 4 or 5 gallons of water is the proper strength for plants in leaf.

A solution of whale-oil soap and water is sometimes used for San José scale, applying it to trees in winter, while they are dormant. For such use, take 2 pounds of the soap to 1 gallon of hot water. This material is not as effective against scale as lime-sulphur solution, and the cost is greater.

Carbolic Acid Emulsion

Hard soap	1 pound
Hot water (soft)	$\frac{1}{2}$ gallon
Carbolic acid (crude)	1 pint

Dilute as directed.

This is one of the remedies occasionally recommended for killing root maggots. These maggots are not properly sucking insects, but because of the conditions under which they are found, the use of a contact insecticide is sometimes recommended.

Carbolic acid emulsion is prepared in the same manner as kerosene emulsion. Dissolve 1 pound of hard soap in $\frac{1}{2}$ gallon of boiling water. Then add 1 pint of *crude* carbolic acid, and at once churn the mixture by pumping it back on itself with a bucket pump until a smooth emulsion is formed.

This is the stock material. To prepare for use dilute at the rate of 1 part of the stock emulsion to 50 parts of water.

CHAPTER XVI

Repellents

Occasionally some chemical is found to be of service in driving away insects at work on a plant. Many remedies of this nature are proposed from time to time, but in most cases further tests prove that they are without real value.

Dry-slaked lime is of service in driving away certain pests, such as the striped cucumber beetle. To prepare, place fresh lump lime in a metal vessel and add a small amount of hot water. The lime will slake to an extremely fine powder. This is dusted on the insects. If desired, flowers of sulphur may be added to the slaked lime.

Tobacco dust is reasonably effective as a repellent. It must be fresh, and is dusted directly on the insects; or when used as a preventive of attack by root maggots, the dust is heaped up around the stem of each plant.

Naphthaline, or "moth balls," is of moderate value as a repellent for such insects as the common clothes moths, or for some of the pests that infest dried animal products. This material is not, however, a complete protection. It should be noted, further, that if moths have already laid their eggs on garments, and the latter are afterwards packed away with naphthaline, no benefit whatever will be secured. The substance is a repellent solely for the adult moth, and not for the larva, which does the real damage.

Protective Wash for Trunks of Trees

Dissolve 2 quarts of strong soft soap in a bucket of water. One pound of hard soap may be used instead of the soft soap. Add ½ pint of crude carbolic acid and 2 ounces of Paris green. Then add lime, or clay, or both, so as to make a thick paste.

Paint this on the trunks or limbs of trees as a deterrent for borers. It will not give entire protection, but will help to ward off attack.

CHAPTER XVII

Fumigants

In general, fumigation is available for killing insects only when the plants or substances treated are in an inclosed space. This is for the reason that the various gases which are the active killing agents in any fumigation must be confined to be effective.

Fumigation is commonly used in greenhouses, in the treatment of pests infesting stored or manufactured products, and in the treatment of nursery stock suspected of infestation with San José scale. The methods employed and the strengths of material used vary with these different classes of work. The general manner of using the chemicals, and the principles involved, are similar.

Carbon Bisulphide

Carbon bisulphide . . . 1 pound to each 100 cubic feet

This is the material ordinarily used for killing pests of stored and manufactured products, except in grain elevators where the risk of accidental fire is considered too great. It is a clear, heavy liquid, with a strong and disagreeable odor. On exposure to air, it evaporates rapidly, giving off a gas that is heavier than air, and therefore diffuses down rather than up.

Allow 1 pound of carbon bisulphide for each 100 cubic feet of space in the fumigating chamber. Or, if grain is being fumigated, allow 1 pound of the liquid to each 100 bushels of grain. In small quantities this is about equivalent to 2 drams to the bushel.

This is the dosage at ordinary temperatures of 60° to 70° Fahrenheit. At much lower temperatures a heavier dose will be required,

and at higher temperatures one half to three fourths of the above will suffice.

Place the material to be treated in a box, barrel, or bin that can be made at least fairly air tight. Pour out the carbon bisulphide in one or more shallow dishes, and place on top of the materials. Put on the cover at once, and leave for twenty-four hours. Blankets or canvas thrown over the top of the box will assist in retaining the fumes. *Do not allow any fire, or even a lighted cigar, anywhere near at the time of fumigating or for a period after*, until the fumes have disappeared.

Use reasonable care not to breathe the fumes too much or too long at a time, as they will be apt to cause headache or illness. No inconvenience should be experienced if ordinary care is exercised.

If large amounts of grain are being fumigated, it is best to introduce some of the liquid to the middle layer of the heap instead of putting all on top. To do this, fit a round stick loosely in a section of small iron pipe. Leaving the stick in the pipe, shove it down through the grain. Then withdraw the stick, and pour the desired amount of the carbon bisulphide down the pipe. The stick merely serves to keep the grain from filling the pipe when it is shoved down into the heap. After being fumigated, the grain should be shoveled over, so as to help remove the gas remaining in it.

Carbon Tetrachloride

Carbon tetrachloride . .	2 pounds to each 100 cubic feet

A substitute for carbon bisulphide is found in carbon tetrachloride. It has the advantage of being nonexplosive, and therefore may be preferred in fumigating bins in a house or barn, or wherever there is possible danger of fire. It is not as active as carbon bisulphide, and will not kill insects as readily.

The proper strength to use is 2 pounds of carbon tetrachloride for each 100 cubic feet of space or each 100 bushels of grain. In small quantities use 4 drams to each cubic foot or each bushel of grain.

Sulphur

Under some conditions a satisfactory fumigation may be had by burning sulphur at the rate of 2 pounds to 1000 cubic feet. It should be noted that the fumes are harmful to vegetation, that they will bleach fabrics, and that they will destroy the germinating power of seeds. As a means of killing bedbugs in empty rooms the treatment is excellent.

Place the sulphur in a fire-proof vessel, and this in turn within a larger vessel, and ignite. Keep the place closed for 24 hours.

Hydrocyanic Acid Gas

The most active fumigating agent in use is hydrocyanic acid gas, made by combining water, sulphuric acid, and potassium cyanide. *This gas is a deadly poison* to man as well as insects, and its use should not be attempted unless careful precautions are taken, or the operator has had experience. It should never be used for fumigating any part of an inhabited house, unless the entire premises can be vacated for two or three days until the structure is thoroughy aired.

For fumigating nursery stock, the materials are used in the proportion of 1 ounce of 98 per cent potassium cyanide, 2 ounces of commercial sulphuric acid, and 4 ounces of water for each 100 cubic feet of space in the fumigating chamber. The chamber is kept closed for 40 minutes. To generate the gas, have ready an earthen crock of generous size. Pour the necessary amount of water into the crock, and slowly add the sulphuric acid, stirring the mixture. Never reverse this order and pour the water into the acid. Considerable heat will be generated. Place the proper amount of potassium cyanide in a paper bag, or tie up loosely in paper, drop the package into the crock, and at once leave the room, closing it up air tight. A convenient way of adding the cyanide is to suspend the bag over the crock with a string, the other end of which is led through a small hole in the fumigating chamber, so that the operator can retire first and seal the door, and then lower the bag of cyanide into the acid.

In fumigating a house, or a part of a house, the materials are combined in the same manner as above, but the proportions to use are 1 ounce of cyanide, 1 ounce of sulphuric acid, and 3 ounces of water to each 100 cubic feet. All cracks should be sealed or stopped up. Gummed paper is useful for this purpose. After the fumigation is complete, the house must be aired out by opening the windows from the outside. Fumigation of dwellings ought never to be attempted unless one thoroughly understands the process and the necessary precautions.

In greenhouses the amount of material to use cannot definitely be specified in advance, and ought always to be ascertained by careful preliminary trial. Different plants will withstand varying amounts of the fumigant, and much depends on the tightness of the house.

It is best to begin with a dose of $\frac{1}{4}$ to $\frac{1}{2}$ ounce of cyanide to the thousand cubic feet, continuing the treatment for about 2 hours, at once airing the house and observing results. If the insects are not all killed, and the plants are uninjured, the dose may be made a little heavier.

Fumigation in greenhouses must aways be done at night, and the leaf surfaces must be dry. The house may be aired out late the same night or early the next morning, before the sun is hot.

Greenhouse fumigation is of special value against mealy bugs, white fly, and violet aphis, because other possible treatments are injurious to the plants or ineffective. It is not successful against scale insects or red spider.

When greenhouses are cleared of plants between crops, they should be thoroughly fumigated, using the cyanide at the rate of 5 to 8 ounces to the thousand cubic feet and continuing the treatment over night. Valuable protection will thus be secured for the succeeding crop.

Fumigation with Tobacco

For the control of most plant lice in greenhouses, fumigation with tobacco is a common method. This cannot be employed in houses containing violets, since the fumes will spot the leaves.

The usual method is to burn stems or dust, or to vaporize liquid extracts of tobacco, or to make use of a specially prepared punk now on sale in stores. The last is usually the most satisfactory method.

It is desirable in tobacco fumigation to generate the smudge near the level of the floor, because it rises rather rapidly, and if generated at the height of the benches, much of the strength of the fumigant will be concentrated near the roof.

CHAPTER XVIII

Fungicides combined with Poisons

Materials that are used for the control of plant diseases, such as scab, mildew, and the like, are called fungicides, as contrasted with materials used for the destruction of insects, called insecticides. Fungicides are not intended for the control of insect pests, and for the most part *have no value whatever in insect warfare.*

However, one of the materials commonly used for plant diseases, Bordeaux mixture, has also some effect in driving away certain insects from plants, or at least is distasteful to them. A second fungicide, lime sulphur, as prepared for use in summer on trees in leaf, also has some value as a mild contact insecticide, of considerable efficiency against such soft-bodied sucking insects as plant lice.

In addition, it is common practice to use either of these materials with a poison, such as arsenate of lead, added to it, as a combined insecticide and fungicide, instead of applying the two sprays separately. Directions for their preparation and use, therefore, seem proper at this point.

Bordeaux Mixture

Copper sulphate	4 pounds
Lump lime	4 pounds
Water	50 gallons

Bordeaux mixture is a combination of copper sulphate, often known as "blue vitriol" or "bluestone," with lime and water. It may be bought in paste form, ready to dilute with water and apply; or it may easily be made at home.

To make Bordeaux mixture, place 25 gallons of water in a barrel, and suspend in it, just below the surface, a cloth bag containing 4

pounds of copper sulphate. Allow the copper sulphate completely to dissolve. If it is desired to hurry this part of the process, the sulphate may be dissolved in hot water, using about 2 gallons and stirring well, and this may then be poured into the barrel and the latter filled up to 25 gallons. In another barrel slake 4 pounds of lump lime, adding more water and stirring well as the lime dissolves, until there are 25 gallons in the barrel. Then combine the sulphate solution and the limewater by dipping alternately from each into the spray tank. Or, the two may be poured slowly at the same time into the spray tank. It is essential that the mixture be thoroughly strained as it goes into the sprayer.

On some plants the above formula for Bordeaux mixture is too strong, and should be altered to the following: copper sulphate, 2 pounds; lump lime, 2 pounds; water, 50 gallons. The method of making is the same.

Bordeaux mixture must be used as soon as prepared. If allowed to stand, it changes in composition. More lime may be added, and the material thus made use of, but this procedure is not recommended.

Where this material is used in large amounts it is convenient to prepare separate stocks of copper sulphate solution and lime "putty." Kept separate, they will not deteriorate. Dissolve the copper sulphate in water at the rate of 1 pound of the sulphate to 1 gallon of water. One gallon of this concentrated solution will then equal 1 pound of the sulphate. To prepare lime putty, place a known weight of lump lime in a flat trough and add just enough water to slake it. When it is all slaked, see that it is spread out evenly and cover with an inch or so of clear water, to exclude the air. It will be easy to figure out the number of square inches of putty to remove in order to have the equivalent of the desired weight of lump lime. Do not make the mistake of weighing out this putty and considering that a given weight is the equal of the same weight of lump lime.

Arsenate of lead may be combined with diluted Bordeaux mixture; but the better plan is to add it to the limewater before the final mixing. The poison should first be well mixed with water, so as to make a thin paste, in order that all of it may find its way into the final mix-

ture. If this is done, allowance must be made for the volume of the arsenate of lead solution when filling up the barrel of limewater to the requisite 25 gallons.

A ready prepared Bordeaux paste containing arsenate of lead is on sale in stores.

Summer Strength Lime Sulphur

Summer strength lime sulphur is now coming into use as a fungicide for the control of certain diseases. While this is similar, chemically, to the lime-sulphur wash used as a winter spray for scale insects, it is much weaker. It is prepared by proper dilution of the commercial concentrated solutions, or by a so-called " self-boiled " method, in which the chemical composition is somewhat different. The proper dilutions of lime-sulphur concentrate for summer spraying of apples, making use of the Baumé hydrometer as a measure of strength, are as follows:

In Degrees Baumé Reading of Hydrometer	Number of Gallons of Water to One Gallon of Concentrate
35	45
34	$43\frac{1}{2}$
33	$41\frac{1}{4}$
32	40
31	$37\frac{1}{2}$
30	$36\frac{1}{4}$
29	$34\frac{1}{4}$
28	$32\frac{3}{4}$
27	31
26	$29\frac{1}{2}$
25	$27\frac{3}{4}$
24	26
23	$24\frac{1}{4}$
22	$22\frac{3}{4}$
21	$21\frac{1}{4}$
20	$19\frac{3}{4}$
19	$18\frac{1}{4}$
18	17
17	16
16	15
15	14
14	$12\frac{3}{4}$

Remember that these are the dilutions for summer strength lime sulphur to be used on apple trees in leaf, and not for the winter wash, which is much stronger.

The *self-boiled lime sulphur* is for summer use only, and has nothing to do with the winter wash used for scale insects. The method of making is as follows:

Place 20 pounds of lump lime in a barrel and pour over it 3 gallons of *cold* water. As soon as the slaking is well started, add 20 pounds of flowers of sulphur, which must be free from lumps. Begin stirring the mixture as soon as the sulphur is added. A violent heat will be genrated by the slaking of the lime, and it is this that brings about the desired combination of the two materials. Now add more cold water until the mass has the consistency of paste. The boiling will subside in from 5 to 15 minutes, and *at once* more cold water must be added so that no further action will take place. There should be none of the red liquid that indicates the formation of the chemical compounds characteristic of the winter wash. The mixture may now be diluted for use by adding water until there are 100 gallons all told. Great care should be taken to follow the above directions accurately, for if the boiling is continued too long, compounds will be formed that will burn tender foliage. In no case should hot water be used instead of cold, either for slaking the lime or for the dilutions.

Arsenate of lead may be added to the summer strength lime sulphur, thus providing a combined fungicide and poison insecticide, with certain additional properties as a contact insecticide. This applies either to the diluted concentrate or to the self-boiled lime sulphur.

CHAPTER XIX

Spray Machinery — General Principles

Several important considerations should be taken into account in the selection and care of spray machinery and appliances. Chief among these are the following:

The spray pump should be of adequate size for the work for which it is intended to be used. As will be noted below, there are many different sizes and styles of pumps, ranging from the hand atomizer with a capacity of a quart or less of spray material, and suitable only for a very limited use, to the heavy power outfit fitted with a 200-gallon tank, and capable of throwing a stream 70 feet into the air. Either outfit would be absolutely unsuited to the work of the other. While these two examples are at the extremes, the same principle holds good, in lesser form, to other outfits that grade in between these two. It is poor economy to save four or five dollars on an outfit and expend several times that amount each season in extra labor and time. The first question to be decided, therefore, is that of the type and size of pump that will be best adapted to the work in hand.

Whatever the style of pump decided on, it must be made of proper materials. Some of the spray solutions in common use have a corroding action on iron. The only material that will withstand their attack is brass or bronze, and care should be taken to get a pump in which all the metal working parts that come into contact with the liquid are of heavy brass or similar alloy. This applies to the inside of the cylinder, the piston, the valves, valve seats, and any other submerged parts where close fitting is essential to the smooth and satisfactory working of the apparatus.

Lately pumps have been placed on the market in which the inside of the cylinder is coated with a heavy, white enamel. If this is so

applied that it presents a perfectly true surface for the piston, and if the enamel is so baked on that it will not chip or wear rough from the grit that invariably gets into spray material, such cylinders should prove satisfactory.

A pump must have an efficient mechanical agitator, which will automatically keep the liquid thoroughly stirred. A jet of liquid forced out in the vicinity of the intake is insufficient. Agitators of the paddle type, connected in some fashion to the pump handle or piston rod, are in general use, and are fairly effective. Another style of agitator works on the principle of a propeller, and gives excellent service.

The size of air chamber is important. If it is large, the operator of the pump will find that a steady pressure can much more easily be maintained. Power pumps are apt to have air chambers of proper size, because if lacking, they will quickly tell on the working of the engine, especially if the latter is of the single cylinder type. Some of the smaller hand pumps would be more efficient and would work more easily if provided with a more generous air cushion. It should be remembered that the spray liquid is only to a minute degree compressible, whereas air is resilient and absorbs the variations in pressure between strokes.

Valves are necessarily a part of every pump, and are of various types. Those in commonest use are the poppet valve, the swing check, and the ball valve. Of these the ball valve is apt to give the best satisfaction, if it is made of proper materials. The action of the liquid tends constantly to turn the ball this way and that as it rises and falls, resulting in equal wear all round, both as regards the ball and the seat. Poppet valves with a single rod guide beneath to hold them in line are very likely to wear unevenly and later to leak, resulting in weakened efficiency. Any valve with a straight or square, instead of a beveled seat is apt to give trouble. All poppet valves present the following difficulty: they tend to seat in identical positions, and if grit or other foreign matter gets in, there is leakage at one point, which does not promptly right itself and soon results in uneven wear. It is essential to the satisfactory working of a pump that its valves fit accurately and do not leak.

Ease of getting at the working parts of the pump is worthy of con-

sideration. In spite of the care that may be exercised in keeping the apparatus in good order and straining all materials used, there will be occasions when it becomes essential to inspect the valves or other working parts. If, in order to do this, it is necessary to dismount the pump, or to take it entirely to pieces, much time will be lost — probably on the very day when time is most valuable. Some of the barrel pumps first placed on the market were entirely inclosed in a heavy metal casting, and required much time and labor for inspecting their working parts. Later types have eliminated this, although some of the older pumps are still on the market.

The piston packing should present adequate surface, and the packing itself should be easily replaceable. In some makes of pumps provision has been made for tightening up the packing from the outside. Leather is not a good material for packing. The chemicals used in spray materials will soon harden it and render it unfit for service.

In some makes of barrel pumps a stuffing box is employed in place of piston packing. The objection to this is twofold: it makes a rather more complicated apparatus, and it is difficult or impossible to avoid excessive friction. In the horizontal, double-action pump a stuffing box is necessary, because of the design of the pump, but in this case, there is so much gain in efficiency in other ways that the objection noted may be disregarded.

CHAPTER XX

Types and Sizes of Spray Pumps. Dusting Apparatus

Atomizers

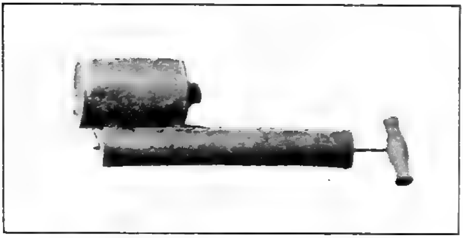

Fig. 56.—A hand atomizer. Original.

These are small and cheap devices, producing a spray by the principle of driving a current of air across a small outlet tube. They are provided with a metal or glass tank holding about one quart, and are adapted for use on house plants, or similar light work.

Bucket Pumps

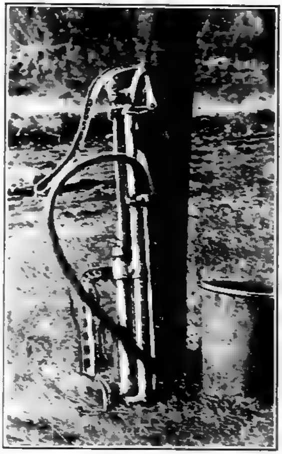

Fig. 57.—A bucket pump. Original.

Bucket pumps are suitable for work in a small garden, and for whitewashing or spraying poultry houses. They may readily be fitted with a longer hose and an extension rod, and may then be used for spraying fruit trees, if one has only a few trees to treat. In garden spraying their principal disadvantage is the fact that one cannot work rapidly when compelled to move a bucket along a few feet at a time, and that it is not always easy to manipulate the pump, and at the same time direct the spray where needed.

Knapsack Pumps

Knapsack pumps consist of an oblong tank furnished with straps for hanging on the back, and provided with a small, inclosed pump, the handle of which projects forward over one's shoulder. They are not in general favor. The apparatus is fairly heavy to carry, and is likely to spill liquid down one's back.

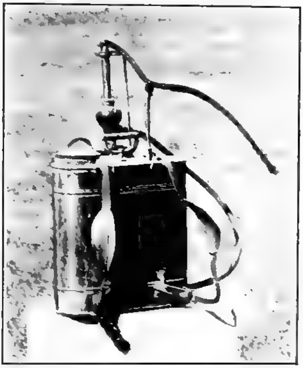

Fig. 58.—A knapsack sprayer. Original.

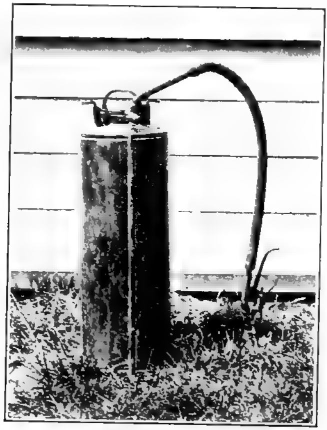

Fig. 59.—An automatic sprayer. Original.

Automatic Sprayers

Automatic sprayers are air-tight cylinders designed to be carried by hand. The cylinder is filled partly full of the spray material, the top fastened on, and by means of a self-contained pump air is forced in until the liquid within is under pressure. A valve allows the spray to be driven out through the nozzle as desired. The apparatus is handy, and desirable for garden work. Its principal disadvantage is the lack of an agitator. Only the brass sprayers should be purchased. Those in which the tank is made of iron, while cheaper, will not give satisfaction.

A light extension rod may be attached to the cylinder, and the apparatus used for spraying small trees, if only a few are to be treated.

Barrel Pumps

Barrel pumps of one type or another are in use in the majority of orchards of moderate size where any spraying is done. Usually they are mounted directly on a 50-gallon barrel, which serves as the spray tank. Such pumps have a capacity ranging from 1 to 4 gallons of

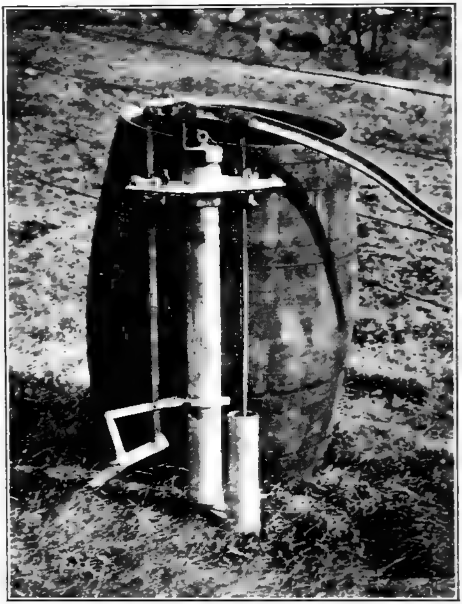

Fig. 60. — A barrel pump. Original.

liquid per minute, and are intended to operate at a pressure of 100 to 125 pounds. They are capable of furnishing material for two leads of hose. Commonly the outfit is placed on a wagon of some kind, or on a sled. Unless the trees to be sprayed are headed very low, there should be a simple tower or elevated platform, about 4 feet high, bolted to the wagon, on which one of the operators may stand while the other works from the ground.

Horizontal Pumps

Horizontal hand pumps are typically of the double-action type, and have a capacity of 3 to 5 gallons of spray material per minute. They have a marked advantage over barrel pumps in that the handle is longer

Fig. 61. — A convenient tower used in connection with a barrel pump. Original.

and works in such position that the operator can maintain the desired pressure and volume with much less effort. They do not bring the constant strain on the muscles of the back, characteristic of barrel pumps, and since they are double acting, both the forward and the reverse strokes count. In efficiency, pumps of this type are nearly the equivalent of the smaller power outfits.

Traction Outfits

Traction sprayers derive their power from the wheels of the vehicle on which the pump and tank are mounted. They are especially useful in spraying grapes, potatoes, or other field crops; in other words, they are adapted to the kind of work in which one desires a continuous spray delivered constantly at a definite position or angle. For spraying of this character they may properly be selected. For general orchard work they are not suited unless there is some arrangement by which the gearing may be disconnected and the pump operated by hand when desired. Outfits of this kind should always be provided with a large air chamber, a pressure gauge in plain sight, and a relief valve which will open at a certain pressure and allow the liquid to flow back into the tank. The capacity of traction sprayers is figured on the basis of a vehicle moving at the rate of 250 feet a minute, and ranges from 5 to 18 gallons of liquid per minute. The connection to wheels is made by eccentric, chain, or gearing.

FIG. 62.—A horizontal pump. Original.

Hand traction sprayers operate on the same principle, but are much smaller, are intended to be wheeled about by hand, have a tank of about 20 gallons capacity, and are so arranged that the pump may be thrown out of gear and operated in the same fashion as a barrel pump.

They are fairly satisfactory, but are apt to prove heavy and hard to manage. In one type the construction is such that a single horse may be hitched to the outfit, which is then guided by the operator much in the manner of a plow.

Power Sprayers

Power outfits consist essentially of a gasoline engine, a rather heavy pump geared or belted to the engine, and a large tank, the whole

Fig. 63. — A gasoline power sprayer. Original.

mounted on skids or on wheels. Such outfits range in capacity from 4 to 12 gallons of spray material per minute, and are operated at a pressure of 200 pounds or more. The pumps used may be of the large, single cylinder, single-action type, or double action, or multiple cylinder. The engines in the smaller and medium size outfits are usually of $1\frac{1}{2}$ to 3 horse power, single cylinder, and either air or hopper cooled. In the recently designed, extremely powerful outfits, used for spraying tall trees from the ground, the engine is of the automobile or marine type, with two, three, or four cylinders. The main advantages of power outfits include the rapidity with which the work can be accomplished, the saving of hand labor at pumping, and the high pressure at which the spray is applied. Where many trees are to be sprayed, the power outfit will do the work at less cost per tree than the less expensive, smaller outfit.

Compressed Air Outfits

Compressed air sprayers are in use in some orchards. In this type of apparatus the sprayer itself consists simply of two large steel tanks mounted on skids or wheels, and fitted with the necessary leads of hose. One of the tanks is filled with the spray material, while in the other air is stored under considerable pressure, usually 160 pounds. Pipes connect the air tank with the liquid tank, and the spray material is agitated by arranging the inlet of air in such fashion that it comes out of a number of jets at intervals along the bottom of the liquid tank. The air is compressed at a central station by means of an air compressor using gasoline or other power. It is customary to have two or more of the sprayers, so that one may be at the central station receiving its spray material and its charge of compressed air, while the other is in the orchard. Usually the air pressure is reduced to about 80 pounds by the time a sprayer has discharged its liquid and is ready to return to the central station. The system has the advantage of rather rapid work, and of comparative simplicity, so far as the sprayer itself is concerned. Its disadvantages are the fact that it operates necessarily at a constantly changing pressure, thus tending somewhat to uneven work, and the high cost of installing the plant.

Dusting Apparatus

Various types of machines are obtainable for applying insecticides in powder form. Most of these are designed to be carried by hand, and rapid work can be done with them under suitable conditions. They are not so well adapted to applying materials to trees, nor to situations that are difficult to reach because of thick, intervening foliage — as, for example, in treating vineyards. But for use on truck or field crops, especially in the application of powdered arsenate of lead, they have a growing utility. In the more desirable types a constant stream of air is maintained by a rotary fan, and the powder may be directed through one or more outlets as desired. The amount of material delivered may also be regulated.

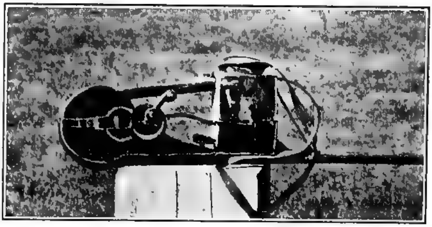

Fig. 64. — A geared powder gun. Original.

For dusting field crops a simple device is in use in the South, consisting of a pole 4 to 8 feet long, to which are tacked cloth bags at proper intervals, according to the distance between rows. A hole bored through the pole above the bag provides a means of filling it. Often the pole is set across a horse's back, the jarring being sufficient to sift the poison through the cloth.

CHAPTER XXI

Accessories

Nozzles

Nozzles, as now designed, have reached a point of greater efficiency than was the case a few years ago. On small hand outfits, adapted for the kitchen garden, the question of nozzle is not so important. It is neither possible nor necessary to get up heavy pressure with these outfits, and the amount of work to be done is comparatively light. But in orchard spraying, particularly on a large scale, the nozzle may greatly help or hinder rapid and satisfactory work.

The so-called *Bordeaux* nozzle is one of the older types still in use on light hand outfits. It has an adjustable opening, which may be arranged so as to throw a semisolid, fan-shaped stream, or a fairly fine spray. This nozzle is entirely unsuited to orchard work on any considerable scale, but is well liked for vineyard or field spraying because the nozzle can quickly be cleaned by reversing the core.

The *vermorel* nozzle has a central orifice, back of which is usually some particular type of chamber. As originally designed, the entire nozzle was small, and the central opening decidedly so. It invariably clogged up in short order, and hence was, and is, made with some sort of needle built into the central line of the nozzle, and so arranged that this needle can be forced forward to clear the orifice. The nozzle gives a fine, mist spray. Its defects are its intolerable tendency to clog and the fact that it can deliver only a small quantity of spray material; in other words, it is of low capacity. However, on light hand outfits, it is in general use and is fairly satisfactory.

The modern *disk* nozzle was evolved from the vermorel. It differs

from the old form in being much larger, in having a larger orifice, and in relying on the design of the chamber back of the orifice, combined with an interposed plate, to give the finely divided spray desired. It has large capacity, especially when operating under the heavy pressure generated in a power outfit. The tendency to clog is reduced, but unfortunately is not by any means entirely eliminated. At the present stage in designing, it is the most satisfactory and efficient nozzle for ordinary orchard work. Practically all of the manufacturers of spray apparatus are making a nozzle of this type.

For special work in spraying shade trees from the ground still another type of nozzle has lately been evolved. This is essentially a heavy brass

FIG. 65. — Types of nozzles. On the left, the vermorel; in the center, the disk type; on the right the Bordeaux. Original.

tube, from three to six feet in length, with gradually diminishing bore, ending in a simple round orifice, from one eighth to three eighths of an inch in diameter. It is operated under extremely heavy pressure, and sends high into the air a solid stream which breaks into a fairly fine spray as it nears the summit of its arc. Naturally the material is delivered at a rapid rate. The advantage for extensive work on shade trees lies in eliminating the necessity of climbing the trees, thereby reducing the cost of spraying in spite of the amount of material used.

Extension Rods

Extension rods are necessary in orchard spraying, in order to elevate the nozzles to a point where the spray can reach the upper parts of the tree. Such rods are of two types: small iron pipe, and metal-lined bamboo. Iron rods are more commonly used, and are satisfactory, except

for their weight. They are more easily grasped if wood handles are fitted around them. Bamboo rods are lighter, and therefore tire the operator less. Those lined with aluminum sometimes cause trouble through the twisting off of the connections at the lower end of the rod. Where aluminum is used the metal should be of heavy gauge at this point, and should be one of the harder alloys.

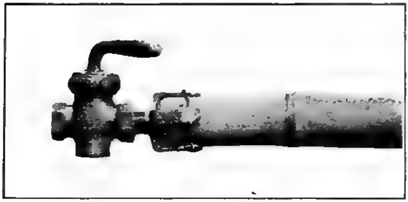

FIG. 66.—Cut-off and end of bamboo extension rod. Original.

There should be a cut-off at the lower end of the extension rod, and it should have a handle of sufficient size to give a good grasp for turning on or off. Unless rods are provided with an easily operated cut-off, much spray material will be wasted in working from one part of a tree to another or from tree to tree.

Hose

Hose leads are essential for barrel or power outfits. The length of hose naturally varies with the character of work contemplated. If two leads are used from a single pump, and one operator stands on the spray wagon or on an elevated platform, it is convenient to have the hose in two lengths, the longer for the man on the ground and the shorter for the man on the platform. One half or three eighths inch hose may be used. The former transmits the pressure to better advantage; the latter is lighter to handle.

Hose connections deserve consideration, especially in outfits designed to work under considerable pressure, as in power apparatus. The long connections, which admit of two bands on each side instead of one, should be selected.

In high-power outfits for shade-tree work, special hose is needed. Connections are obtainable for this work which are provided with bands fastened mechanically to the unions, so that the hose cannot come apart when being dragged over the ground.

Strainers

An essential part of any outfit is a good strainer. Many spray materials contain a great deal of sediment, and the coarser parts of this must be removed if long life is to be expected of the pump, or continual clogging of the nozzles avoided. Furthermore, unless all materials are carefully strained as they are poured into the spray tank, various sorts of foreign matter, such as waste, filings, or bits of wood or leaves, will get into the tank and be sucked up into the pump, where they will cause trouble.

A satisfactory strainer can be made by cutting out the central portion of the bottom of a 12-quart pail, fastening a large funnel securely beneath, and a generous cone of wire cloth above, within the bucket. The edges of the wire cloth forming the cone should be soldered together.

Another excellent type consists of an oblong box, one end of which is made somewhat sloping, so that the affair can be set into the opening of the spray tank without binding. The box is without top or bottom. An oblong piece of wire cloth is fastened into the box at an angle, so that one end of it is nearer the top than the other.

In both of these strainers the essential feature is that the wire mesh shall be so fixed that sediment will not clog it. In either one the spray material will constantly wash clean the upper part of the screen. Sediment that collects along the bottom of the screen can readily be dumped out from time to time. The wire cloth used should be of brass, 20 to 30 meshes to the inch. Nothing else will give satisfactory service.

Spray Tanks

The ordinary size of spray tank for use with a hand pump in orchard work is 50 gallons. Frequently the tank consists of a barrel, with a pump mounted on its end or side.

For use with a power pump the spray tank should be larger, preferably of 150 to 200 gallons capacity. The best type is the half round, because it may more easily be tightened up and kept from leaking. All-round stave tanks, if provided with some means of tightening the hoops

readily, are satisfactory. Iron tanks are somewhat objectionable because if copper compounds, such as Bordeaux mixture or copper sulphate solution, are used in such tanks, the chemicals will tend to break down. Other chemicals have a corroding action on the iron.

Mixing Tanks

Where extensive spraying is carried on it is convenient and desirable to provide suitable mixing tanks elevated on a stout platform. By this means much valuable time will be saved in the preparation of materials. In addition, the work of spraying can be completed more promptly, the materials applied when they will do the most good, and advantage taken of favorable weather conditions.

The design of a mixing plant will depend on the nature of the work to be done, the amount of work, the topography of the location, the source of water supply, and like matters. The general principles governing its design are the provision of an adequate supply of stock solution, convenience in mixing, and the utilization of gravity in transferring liquids from stock tanks to mixing tanks, and from the latter to the spray tank. Expensive and troublesome outlet valves may be avoided by using a section of large diameter hose, the free end of which may be fastened up above the level of the liquid in the tank.

PART III

INJURIOUS INSECTS

CHAPTER XXII

Insect Pests of Garden and Field Crops

Wireworms (*Elateridæ*)

Wireworms are slender, cylindrical worms, $\frac{1}{2}$ inch to 1 inch long, their skin brown and shining, the segments showing plainly. They have three pairs of small, dark legs close to the front end of the body. The whole insect looks tough and wiry.

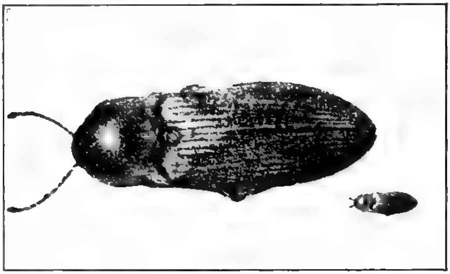

Fig. 67. — Adult of the Wheat Wireworm, *Agriotes mancus* Say. Enlarged and natural size. Original.

They infest a variety of field and garden crops, working on or in the roots or tubers, and are especially injurious to corn and potatoes, though they attack freely wheat, oats, and other cereals.

There are several species, differing in minor characters but alike in general appearance and manner of work. All are the larvæ of "click beetles," or "snapping beetles." Ordinarily they breed in sod ground, the worms feeding on the roots of grasses. In such circumstances their presence is seldom noted, because the ground is so well filled with roots that

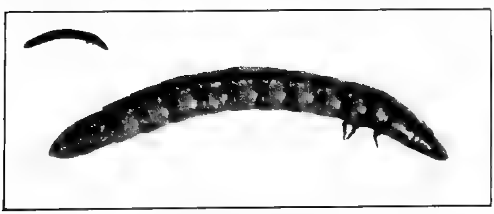

Fig. 68. — The Wheat Wireworm. Enlarged and natural size. Original.

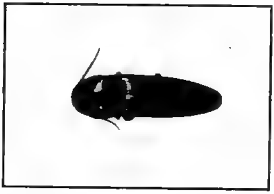

FIG. 69. — A common wire-worm, *Melanotus communis* Gyll. Original.

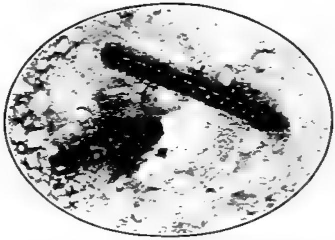

FIG. 70. — Larva and pupa of *Melanotus communis* Gyll. Original.

their work does not attract attention. But when such ground is broken up and planted to potatoes or corn, the worms have comparatively little to feed on, and quickly become a pest. They are slow in development, requiring two years or more as larvæ, so that there are many of them remaining the following year after sod, and often many the second year.

FIG. 71. — Work of wireworms in potato. Original.

Suitable crop rotation, combined with fall plowing and cultivation, is the only means of handling these pests. They do not injure clover or related plants, as a rule, and where fields are badly infested it is wise to put one of the legumes into the rotation following sod. No applications to the soil will kill the worms unless made so strong as also to kill plant life.

White Grubs (*Lachnosterna* spp.)

The presence of white grubs usually is first indicated by the dying off of plants here and there in the field or garden. Corn, and various garden crops as well as strawberries, are subject to marked injury.

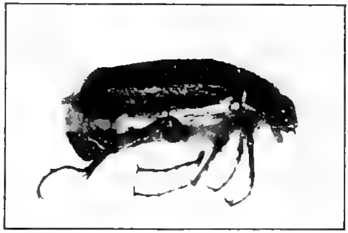

FIG. 72. — Adult of a white grub, *Lachnosterna fusca* Froehl. Original.

Examination of the soil beneath plants attacked will disclose the grubs. They will be found lying somewhat curled up, are soft-bodied, an inch to an inch and a quarter long, and have a brown head. The end of the abdomen is swollen and darkened.

The adults are brown, heavy-bodied beetles, familiarly known as "May beetles" or "June bugs." They fly at night, feed on the leaves of various trees, and are attracted to lights. Eggs are laid in the soil, and about two years are required for the development of the grub. At the end of the second summer the larva makes a pupal cell in the soil at a depth of a foot or less, and transforms to the beetle; but the latter is soft-bodied at first, and does not grow hard and emerge until the following spring. Grass land is the natural breeding place, and injury usually occurs in fields that have been in sod for a number of years, and have recently been broken up for other crops.

FIG. 73. — Larva of *Lachnosterna fusca* Froehl. Original.

Careful planning of crop rotations is the best means of avoiding injury. Fall plowing will help to some extent. Chickens following the plow will destroy the grubs turned up. Hogs are fond of white grubs, and will root up and eat large numbers of them. There is no chemical that may be applied to the soil to kill them.

Leather Jackets (*Tipulidæ*)

Occasionally field crops, such as wheat, grasses, or clovers, are seriously injured by large numbers of naked grubs, the young stages of several species of crane flies (*Tipulidæ*). The adults are slender-bodied very long-legged insects, often known as "gallinippers" or "giant mosquitoes." The grubs are an inch or less in length, dark in color, cylindrical, tough, the hind end blunt. They work just beneath the surface of the ground, eating the roots, traveling from plant to plant in the soil.

The grubs are half grown in the fall, and winter in a dormant condition. In spring growth is resumed. The adults emerge in early summer, and prefer fields that have grown up to tall grasses or other herbage. There is a second generation in summer, the adults laying eggs again in grassland in September.

Plowing before September 1 will place the field in such condition that the adults will not lay eggs in it, and thus protect winter wheat from injury. On grass or clover no effective means of avoiding or stopping attack is known, except plowing up.

Ants (*Formicina*)

Frequently colonies of ants of one kind or another take up their abode in gardens, and prove a nuisance. They can easily be killed by the use of carbon bisulphide. With a pointed stick make several holes into the hills, and then pour into each half an ounce or so of carbon bisulphide, at once pressing the foot on the earth to close the hole. The fumes will penetrate the ground and kill off all of the colony.

In some sections of the Gulf states and in parts of California a persistent and destructive ant has become established: the so-called Argentine Ant (*Iridomyrmex humilis* Mayr). It is a nuisance through entering dwellings, and frequently is destructive in gardens. This species tends to hunt for warm quarters as winter approaches. Advantage is taken of this habit by providing a box of suitable decaying vegetable matter in the garden, preferably a mixture of cotton seed and straw. As this material decomposes it heats, and many colonies of ants, includ-

ing the overwintering queens, migrate to it. The whole thing is then covered with canvas and fumigated with carbon bisulphide. Summer colonies are killed by fumigation in the same manner as described above for other species, or by poisoning with dilute arsenic and sweetened water, as described in the chapter on Household Insects.

The Southern Corn Root-worm (*Diabrotica duodecimpunctata* Oliv.)

The presence of the southern corn root-worm or "bud-worm" is usually first indicated by an enfeebled growth of the young plants. The leaves turn yellow, or the plant simply fails to make a normal, vigorous growth. If a plant is pulled up and the roots are shaken, some of the grubs will likely be thrown out, and the round holes where they have bored into the side of the main stalk, just below the ground, will be noted. The grubs are about three fourths of an inch long when full grown, are quite slender, smooth, white or light yellow, and have a small brown head.

The adult of this worm is a small beetle, about one fourth of an inch long, commonly known as the twelve-spotted cucumber beetle. It is greenish yellow in color, and has twelve black spots on its back. It feeds on the pollen or silk of corn, on a great variety of garden crops, especially cucumbers, squashes, melons, and related plants, and sometimes on the young heads of various grains or grasses.

Control of the root-worm in corn is largely dependent on general farming methods. Crop rotation will help to hold it in check, and so will systematic clean tillage. The worms do not infest the roots of cotton, buckwheat, or the smaller grains. Late-planted corn is less liable to attack, and so is corn in well-drained land. Many farmers find it expedient to plant an excess of seed. Remedies for the adults on garden crops are given elsewhere.

The Western Corn Root-worm (*Diabrotica longicornis* Say)

In the Central states the roots of corn are injured by a small, slender worm which mines in the main roots, tunneling here and there, seriously checking the growth of the plant if not killing it entirely. The worm is

two fifths of an inch long, slender, whitish or yellowish, and has a black or brown head.

The adult is a small beetle, greenish in color, one fourth of an inch in length. It is found occasionally on melons or squashes, along with its relative, the striped cucumber beetle, but is more apt to be seen on sunflowers, golden rod, or thistle blossoms.

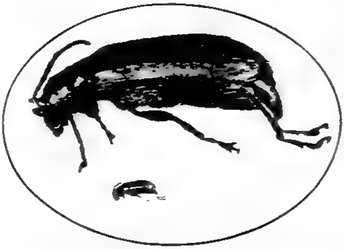

FIG. 74. — The Western Corn Rootworm. Adult. Enlarged and natural size. Original.

FIG. 75. — Work of the Western Corn Rootworm. Original.

There is one generation each year. The winter is passed as eggs beneath the surface of the ground.

The simplest means of control is crop rotation. The eggs are laid only in cornfields in late summer, and the larvæ are injurious only to corn. If corn is planted in fields that have been in other crops, it will not be injured. In practice it is usually safe to run corn two years in succession, changing to another crop the third year.

Corn-root Webworms (*Crambus* spp.)

Young corn plants are seriously injured or killed by several species of webworms feeding on the roots, or on the stalk close to the surface of the ground. The outward evidence of attack is the stunted growth of the corn or the death of young plants. Injury is always worse in ground just broken up from sod.

The same insects attack in similar fashion young tobacco plants in certain eastern sections.

Several species are recorded, all in the genus *Crambus*, and including *C. vulvivagellus* Clem., *C. luteolellus* Clem., *C. trisectus* Walk., and *C. mutabilis* Clem.

The worms feed in a silk tube more or less covered with particles of dirt. They vary in color from yellowish to brown, are three fourths to one inch long when full grown, and their bodies have numerous low tubercles. They hatch from eggs laid by small, active moths which have the habit of resting on grass stems with their wings folded around their bodies. The natural breeding place is grassland. There are two generations annually, the moths of the second brood appearing in the latter part of summer. Winter is passed by the half-grown worms in the soil.

Fig. 76. — Larval case of Corn-root Webworm at base of corn plant. Original.

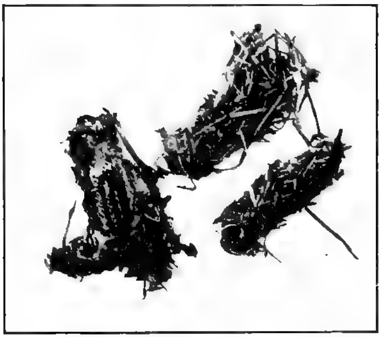

Fig. 77. — Larval cases of a Corn-root Webworm, *Crambus vulvivagellus* Clem. Natural size. The one at the left cut open to show pupa within. Original.

Fall plowing and cultivation will help to hold the pests in check, but to avoid injury do not plant corn in land that is just broken up from sod. Land that is fallowed in the latter part of summer will not be infested the next spring, for the moths will not lay eggs on bare ground.

The Corn Root Aphis (*Aphis maidi-radicis* Forbes)

Colonies of bluish green " lice " suck the juices from the roots of corn, and in certain sections feed also on the roots of other plants, in-

cluding cotton, squash, pumpkin, and strawberries. Plants badly attacked are stunted, lack color, and otherwise show that they are not making a healthy growth. Examination of the roots will then show large numbers of the lice.

The corn root aphis is cared for, and is dependent on, colonies of ants. The latter are usually the common, small, brown ants of the species *Lasius niger americanus* Mayr.

In winter the eggs of the aphis are cared for by these ants, who keep them in their nests, bring them out in the sunlight on warm days and carry them below frost line when the weather is severe. In spring the aphis eggs hatch, and the young wingless lice are carried by the ants to suitable weeds, the roots of which will form acceptable food until the corn has sprouted. Thereafter the ants are in constant attendance on the lice, transferring them to the roots of corn when the latter become available.

FIG. 78.—Larva of *Crambus luteolellus* Clem. Slightly enlarged. Original.

As warm weather comes on, the lice give birth to a second generation of living young, in which winged individuals appear, and these migrate to new fields. Breeding goes on rapidly, the number of generations sometimes reaching a dozen in the course of the summer. In the fall eggs are laid, and these are cared for again by the ants until another season.

In control, the most important measure is to plow and harrow in the fall, so as to break up the nests of the ants. Keeping the fields clean of weeds will help materially, depriving the lice of food in the spring. Rotation is of value, since the first generation of the lice are wingless and by the time winged individuals appear corn will be sufficiently advanced to withstand attack from lice that fly in from other places. It is helpful, also, to keep corn growing vigorously.

Plant Lice attacking Beet Roots

In Washington and Oregon sugar beets sometimes are seriously infested by a plant louse (*Pemphigus betæ* Doane). Affected plants fail to make normal growth, look sickly, and the main root grows spongy. The lice cluster on the smaller rootlets. There are several generations in the course of a single season, and occasionally winged individuals appear and fly to other fields. It is probable that the species lives normally on some wild plant, but the identity of this has not been discovered.

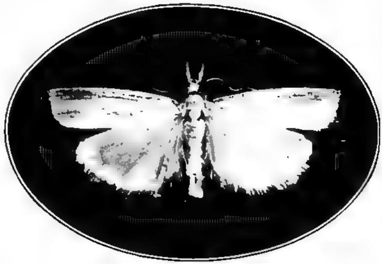

Fig. 79.—Adult of *Crambus luteolellus* Clem. Slightly enlarged. Original.

In Colorado another species, *Tychea brevicornis* Hart., has wrought similar injury.

No direct means of control is known for either of these pests.

The Sugar-cane Mealy-bug (*Pseudococcus calceolariæ* Mask.)

In Louisiana the roots, crown, and stalk of sugar cane are attacked by small, degenerate insects which work in clusters made conspicuous by a white, cottony secretion. The insect itself is soft bodied, pink, and wingless. Only the males are winged, and they are seldom noticed.

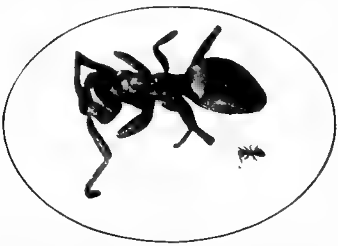

Fig. 80.—The common, brown ant, *Lasius niger americanus* Mayr. Enlarged and natural size. Original.

For the most part they pass the winter on seed cane, but may survive also on Johnson grass. When the seed cane is planted in the spring, the young are transferred with it to the fields. They may hibernate also on cane stubble.

Rotation of crops is the first move towards eradication, combined

with washing the seed cane with whale-oil soap. Remnants of cane in the fields, and Johnson grass in or near by, should be burned.

The Clover Root-borer (*Hylastinus obscurus* Marsh.)

In the Central states clover is subject to considerable injury by this insect, the presence of which is seldom recognized. The adult beetle is small, dark, and cylindrical. Coming out in the spring from clover roots, in which it has passed the winter, it lays eggs in shallow cavities which it excavates in the sides of the larger roots of clover plants in the same or adjoining fields. The grubs that hatch from these eggs burrow in and through the roots, sometimes completely destroying their central parts and killing the plant.

FIG. 81. — Work of the Clover Root-borer. Original.

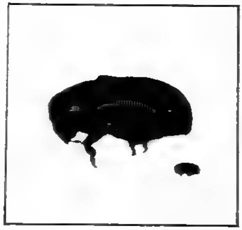

FIG. 82. — Adult of the Clover Root-borer. Enlarged and natural size. Original.

In the latter part of summer the grub changes to a pupa, from which a beetle emerges in fall, but remains in the root until the following spring.

Only two-year-old plants are likely to be attacked. Plowing a badly infested field at once after haying will kill many of the grubs, because the roots will be turned up and dried out. Pasturing a field serves to

check injury or to prevent it. Clover, if infested, should not be allowed to stand after the second season's haying.

The Sweet Potato Root-borer (*Cylas formicarius* Oliv.)

In some sections in the Gulf states the tubers of sweet potatoes, both in the field and in storage, are infested with borers, whitish in color, robust, one fourth of an inch long. The adult is a small snout beetle with dark blue wing covers and brown thorax. It lays its eggs in the end of the tuber where it chances to project from the ground, or sometimes at the base of the vine. There are several generations annually. Eggs may be laid on potatoes in storage.

The only means of control is to keep the tubers well covered with earth. If infested, the crop should be harvested early and at once fumigated with carbon bisulphide.

The Potato-tuber Worm (*Phthorimæa operculella* Zell.)

In California this tiny insect is a pest of prime importance to potato growers. Injury is twofold. The stalks of potato vines are tunneled, the vines badly damaged or killed; and the tubers themselves are

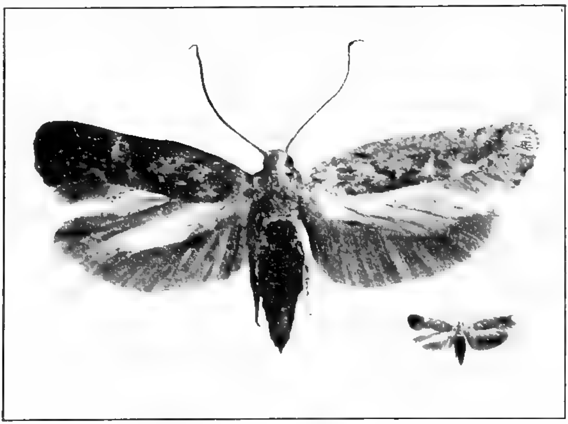

Fig. 83.—Adult of the Potato-tuber Worm. Enlarged and natural size. Original.

attacked, both in the field and in storage. The worm is quite small, only one fourth of an inch long. Eggs are laid on the vine by the parent moth, the grub tunneling down just beneath the skin of the stalk. Or eggs may be laid on potatoes that are not entirely covered with earth. Further damage goes on after the potatoes are dug.

Control consists in cleaning up related weeds, prompt removal of wilting vines, destruction of the vines after digging, and immediate sorting and fumigation of the tubers.

The Cabbage-maggot (*Pegomya brassicæ* Bouché)

The roots of cabbage, cauliflower, turnip, and radish are seriously injured or destroyed

FIG. 84. — Work of the Cabbage-maggot. Original.

FIG. 85. — Cabbage-maggots on cabbage root. Enlarged. Original.

FIG. 86. — Adult of the Cabbage-maggot. Enlarged and natural size. Original.

FIG. 87. — Work of the Cabbage-maggot in radishes. Original.

by soft, whitish maggots, one fourth of an inch long. When working on cabbage, the maggots eat away the root hairs and gnaw into the larger root. Their work is accompanied often by more or less decay of the tissue. When working on radishes, they frequently tunnel entirely within and through the fleshy main root, or cause injury of such a nature that a much-branched root is developed instead of a single, symmetrical tap root.

A hairy, two-winged fly is the parent of the maggots. Eggs are laid on the ground near the stem, or on the stem itself, and the young maggots make their way into the ground along the outside of the stem. There are two to four generations annually.

FIG. 88. — Tool for cutting hexagonal disks. Original.

In the fall eggs, larvæ, and adults may be found in old cabbage stumps.

The maggots may be killed by pouring around each plant a half cup of carbolic acid emulsion. A pointed stick may be thrust diagonally beneath each plant and a teaspoonful of carbon bisulphide poured down the hole.

The maggots may be prevented from gaining access to the roots by fitting a disk of tarred paper around the stem of each plant. The disks should be about four inches in diameter, slit to the center, and marked with short cross cuts at this point, so that they may be fitted closely and easily around the stem. When in place, the disks rest flat on the ground. A handy tool for cutting hexagonal disks in quantity is illustrated. After the first row of cuts has been made across a sheet of cardboard each additional cut will make one disk.

FIG. 89. — Work of the Onion Maggot. Original.

It is of importance to clean up all old cabbage stumps in the fall. Deep plowing will reduce the number of the flies the succeeding year. Rotation of crops is desirable. Abundant fertilization will help cabbages to withstand attack.

The Onion Maggot (*Phorbia cepetorum* Meade)

Infestation by the onion maggot is similar to that of the related species working on the roots of cabbage and radish. The eggs are laid by the adult fly in the leaf sheaths, and the maggots work their way down into the

FIG. 90. — Adult of the Onion Maggot. Enlarged and natural size. Original.

FIG. 91. — Work of the Seed-corn Maggot on the roots of beans. Original.

bulb. There are two to four generations each year.

Practical means of direct control are wanting. Onions should be planted each season in fields as far removed from the previous season's planting as may be. In small plots carbolic acid emulsion may be used. Liberal amounts of tobacco dust along the rows will act as a fair deterrent.

The Barred-winged Onion Maggot (*Chætopsis ænea* Wied.) is a similar species found on onions, and sometimes on the roots of corn and sugar cane. The life history and the remedies are similar.

The Seed-corn Maggot (*Pegomya fusciceps* Zett.)

This insect sometimes works on sprouting sweet corn, but is rather a pest of beans and peas. It is a white, soft-bodied maggot, without legs, and works beneath the surface of the ground, eating into and destroying newly planted peas or beans, especially just as the tender

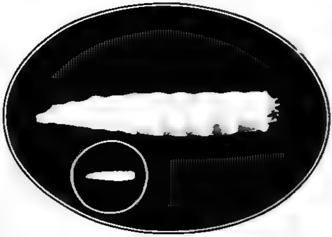

Fig. 92. — The Seed-corn Maggot. Enlarged and natural size. Original.

sprouts are pushing above the ground. A later generation works in similar fashion. The adult is a two-winged fly.

The application of carbolic acid emulsion is the only direct remedy available. Injury is apt to be worse when manure has been applied to the fields in the spring, probably because it attracts the adult flies or offers them shelter.

The Carrot Rust-fly (*Psila rosæ* Fab.)

The leaves of the plants attacked turn red or rusty looking, while the roots are tunneled by small brown maggots, one fourth of an inch long.

Fig. 93. — Work of the Carrot Rust-fly. Original.

On the surface the root may not show much evidence of injury, but when it is cut through, the brown burrows will be evident. Occasionally celery is attacked by the same species.

The adult is a slender-bodied, two-winged fly. There is one generation annually in the field, but breeding may at times go on in carrots in storage.

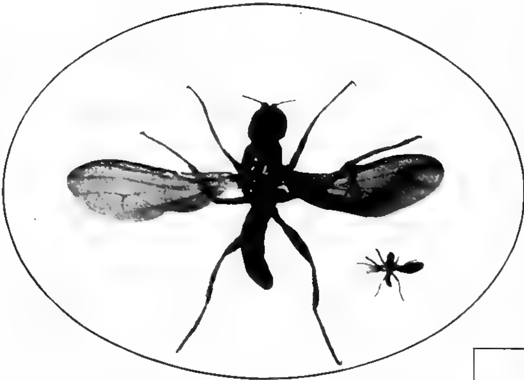

Fig. 94. — Adult of the Carrot Rust-fly. Enlarged and natural size. Original.

Carrots planted late escape serious injury. Direct measures of control are the same as for the onion maggot. Freshly manured fields should be avoided.

The Sugar-cane Beetle (*Ligyrus rugiceps* Lec.)

The stubble and stalks of sugar cane, and the stalks of corn, are burrowed into below the ground by a chunky, black beetle, about half an inch long, with stout, coarsely spined legs. Corn is usually killed, while cane may partly recover and make some growth, though the yield will be short. The injury takes place for the most part early in the growing season.

Fig. 96. — The Sugar-cane Beetle. Original.

Eggs are laid in the ground on the weakened or decaying roots. The larva is a

Fig. 95. — Work of the Sugar-cane Beetle. Original.

fleshy grub. There is one generation annually. The insect hibernates in the soil in cane fields.

Planting of cane should be deferred until spring in order to have opportunity of spring plowing and cultivation. The running of second or third year cane should be avoided. Trash should be cleaned up in the fall. Corn should not follow cane.

The Carrot Beetle (*Ligyrus gibbosus* De G.)

The roots of carrot, celery, parsnips, sugar beets, potatoes, and corn are eaten into by a beetle, which works usually just below the surface of the ground. The insect is black above, reddish

Fig. 97. — The Carrot Beetle. Original.

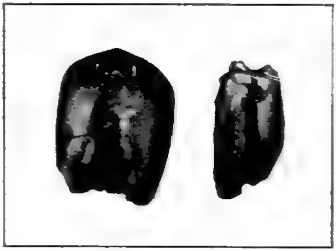

Fig. 98. — Work of the Carrot Beetle. Original.

beneath, and about half an inch long. There is one generation a year. The adults come out in the latter part of summer, and over-winter in the soil. Damage may occur either in fall or in spring.

Fig. 99. — The Seed-corn Agonoderus. Enlarged to twice natural size. Original.

Removal of crop remnants, fall plowing and cultivation, and similar cultural measures are advised.

The Slender Seed-corn Ground-beetle (*Clivina impressifrons* Lec.)

Seed corn planted in low or peaty ground sometimes is injured or destroyed by a small beetle which eats out the heart of the sprouting kernels. The insect is a little

less than a half inch long, dark red, somewhat flattened, and has a large thorax and a fairly narrow "waist."

The pest passes the winter as an adult beetle in the ground. The larvæ are found throughout summer in the ground, and are very active, attacking other insects.

Since only wet ground is chosen by this insect, corn should be omitted from such fields if possible. Late planting apparently serves to discourage the beetles, and to ward off most of the injury.

Occasionally similar damage is done by another ground beetle, *Agonoderus pallipes* Fab. It is a black, oblong beetle, one fourth of an inch long, and destroys corn by eating out the germ end. No direct remedial measures have been devised.

The Corn-stalk Borer (*Diatræa zeacolella* Dyar)

In both Northern and Southern states field corn is subject to serious injury by a borer, the immature stage of a moth, closely related to

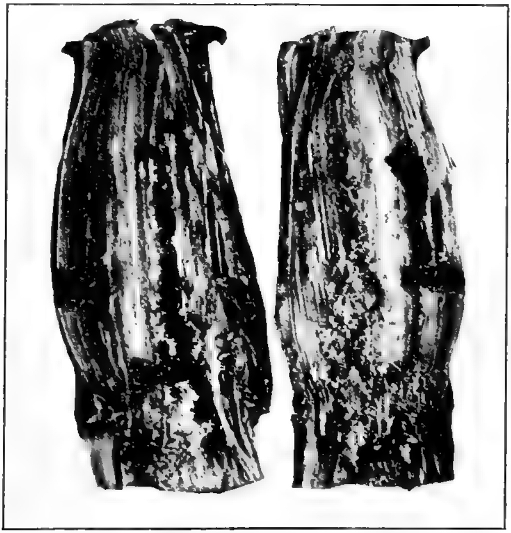

FIG. 100. — Work of the Sugar-cane Borer. Original.

the sugar-cane borer. In early summer, the tender unfolding leaves are found riddled, and often the central part destroyed, so that growth is aborted. In midsummer a new generation of borers works in the pith of the lower stalks, making numerous channels, often causing the stalk to break down in strong winds.

The first lot of moths are out early in the growing season, and lay eggs on the young leaves. In the fall the larva of the second brood burrows down into the base of the stalk, where it spends the winter.

Control measures consist in the removal and destruction of all stalks left in the field in fall. If the stalks are short, they may be plowed under deeply. Rotation of crops will help in control.

The Sugar-cane Borer (*Diatræa saccharalis* Fab.)

The work of this borer in sugar cane is similar to that of the related species in corn. The larvæ destroy the buds or "eyes" by entering the stalk through them, stunting the growth of the young plants, and their burrows so weaken the main stalks that the plants break off in strong winds. In addition the sugar content is seriously lowered.

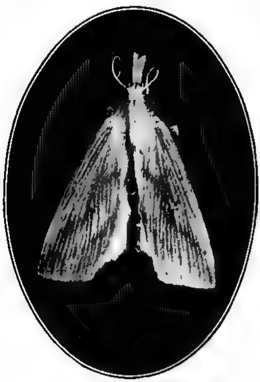

Fig. 101. — Adult of the Sugar-cane Borer. Original.

Eggs are laid on the leaves, and the larvæ feed for a short time in the upper whorls, but soon enter the cane. Pupation takes place within the stalk. There may be several broods annually. Winter is passed as larva or pupa within the cane, and emergence of adults begins early in the spring.

Control is difficult. All tops and trash should be spread out to dry, and burned as soon as possible. Infested cane around sheds and refineries should be destroyed. Shoots and suckers from the stubble of early cut cane should be cut off, so as to cause the death of the young borers within that otherwise would hibernate.

The Smaller Corn Stalk-borer (*Elasmopalpus lignosellus* Zell.)

The stalks of corn, peas, peanuts, and possibly other plants are attacked by a small cylindrical worm, half an inch long when full grown, light greenish in color, its back marked with nine fine, reddish lines, somewhat interrupted at each segment. It works within the stalk, but makes three or four holes to the surface, here and there, through which it pushes out excrement.

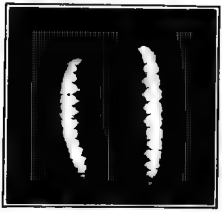

FIG. 102. — Larvæ of the Smaller Corn Stalk-borer. Original.

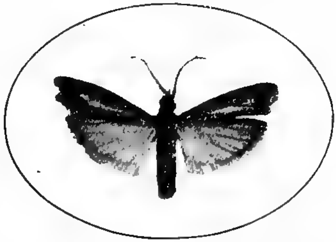

FIG. 103. — Adult of the Smaller Corn Stalk-borer. Original.

The adult moth expands three quarters of an inch. Hibernation may take place as adult, as larva in the stalks, or as pupa in the ground.

The means of control include rotation of crops, prompt destruction of the remnants of infested stalks, and fall plowing and cultivation.

FIG. 104. — Work of the Clover Stem-borer. Original.

The Clover Stem-borer (*Languria mozardi* Latr.)

Tiny grubs are found boring inside the stems of clover. They are the larvæ of a beetle, one third of an inch long, with dark blue wing covers and a red head and thorax. Where clover is regularly mowed

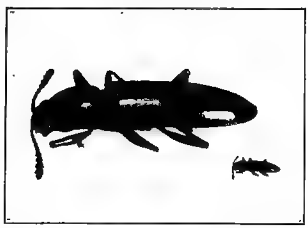

FIG. 105. — Adult of the Clover Stem-borer. Enlarged and natural size. Original.

or pastured, the pest is never abundant enough to demand special treatment.

Bill-bugs (*Sphenophorus* spp.)

Bill-bugs are small, dark snout beetles, one fourth to three fourths of an inch long. Their serious injury is to young corn, and varies somewhat according to the species at work.

Fig. 106. — Work of Bill-bugs. Original.

Fig. 107. — A Bill-bug, *Sphenophorus costipennis* Horn. Original.

The Maize Bill-bug (*Sphenophorus maidis* Chittn.) injures corn, both in its larval stage as a grub burrowing in the lower part of the stalk and the taproot, and

Fig. 108. — A Bill-bug, *Sphenophorus zeæ* Walsh. Original.

as an adult beetle, later in the summer. Infested corn looks unthrifty, is stunted, and later the stalks are distorted and twisted. If a stalk is cut open, the burrow of the grub will be found in its lower part, and up to August the grub itself will be found, a small, thickset larva with a black head. By September the adult beetle, black, two fifths to three fifths of an inch long, will be found in

the lower part of the burrow, about the level of the crown. The beetles hibernate in this position, in the uncut part of the stalk. Control of this species is secured by removal and destruction of the corn stubble, taking care to get the lower part of the plant with the remnant of stalk.

Other species injure corn only as adults. Cavities are eaten in the stalk or through the crown, the punctures showing as the leaves unfold. One of these species passes its larval life as a grub in the bulb of timothy; another in wild sedges growing in wet ground. With these, to avoid injury it is necessary to refrain from planting corn on recently drained ground. If possible, such lands should be burned over.

The Western Grass-stem Sawfly (*Cephus occidentalis* Riley and Marlatt)

In the northwest, in recent years, wheat has been injured by the work of a grub that bores in the stem, causing the kernels to dwarf, and often causing the stem to break over close to the ground. The larva is three fourths of an inch long, yellowish white. The adult is a four-winged sawfly, its abdomen banded with yellow.

Eggs are laid just below the head of the grain attacked. The grub bores down within the stem, girdles it from the inside not far above the ground, and remains below the girdle until the following spring, when the adults emerge. The native food plants are quack grass, wheat grass, brome grass, rye grass, and timothy.

Remedial measures consist in keeping down the growth of native grasses around wheat, and in plowing the stubble in fall or early spring so as to kill the insects hiding within it or prevent emergence of the adults.

The Joint-worm (*Isosoma tritici* Fitch)

The presence of joint-worm in wheat is nearly always accompanied by distortions or enlargements of the stem at the point where the grub is at work. Such parts become hardened, and are apt to come out with the grain at threshing. The heads of badly infested plants

usually are stunted and give a reduced yield, and the straw tends to break down.

The adult of the grub that does this mischief is a small, black, four-winged fly. It lays its eggs in the standing stem of wheat in May or June in the uppermost joint available. Several larvæ may develop within a single stem. The larva remains in the straw until the following spring.

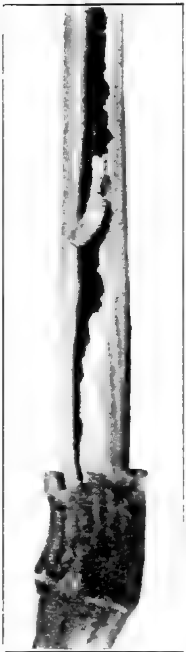

FIG. 109. — The Joint-worm. Larva and work. Enlarged. Original.

In control cut the straw as low as possible, so as not to leave many larvæ in the field. Infested straw not used up by April 1 may be burned, but usually not many adults issue from dry, well-made straw stacks. The best measure is to burn the stubble in the field. Where clover is growing in the stubble, it is possible to choose a time in winter or spring when the clover has been frozen down, and will not be injured. Rotation should be practiced, and wheat kept growing vigorously so that it may be well along by the time the adults come out to lay their eggs. In such plants the larvæ will cause less loss in yield than in backward or weak plants.

FIG. 110. — The Joint-worm. Adult. Enlarged and natural size. Original.

A closely related species, *Isosoma hordei* Harr., attacks the stems of barley, causing a distortion of the stem at the point of injury, and more or less reduction in yield, as in the case of the species infesting wheat. The recommendations for control are the same.

The Wheat Straw-worm (*Isosoma grande* Riley)

In the wheat growing regions west of the Mississippi this insect causes much damage. Its work is of two types. Overwintering, mostly wingless adults lay eggs in April in the tender tissues of young wheat plants. The grubs that hatch from these feed in the crown of the plant, practically destroying it so that growth stops. After a pupal stage a second generation of adults in late May or June emerges. These are winged, and are apt to disperse rather widely. The female lays eggs in the wheat stem, below the head and just above the youngest joint that is not covered with a sheath of leaves. Larvæ hatching from these eggs feed in the stem, and remain in the straw until the next season. The plant attacked will mature a head, but the kernels are apt to be small.

FIG. 111. — Work of *Isosoma hordei.* Original.

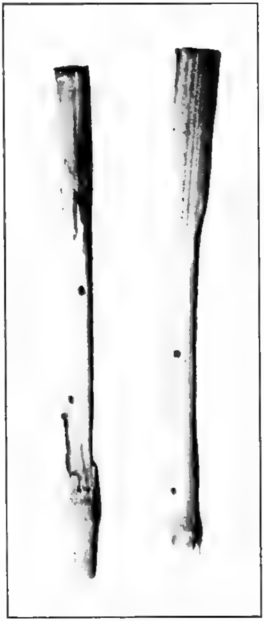

FIG. 112. — Work of the Wheat Straw-worm. Original.

Rotation is important because it will prevent damage by the first, wingless generation, which causes the more serious injury. The overwintering larva can be killed by burning or otherwise disposing of the straw and stubble.

The Wheat-stem Maggot (*Meromyza americana* Fitch)

The evidence of the presence of the wheat-stem maggot is a characteristic blanching of the heads of wheat, rye, oats, or other small

grains here and there in a green, growing field. Often the stem below the head will be somewhat shriveled or discolored. A tiny maggot may be found within the stem. The adult is a small fly with a striped body.

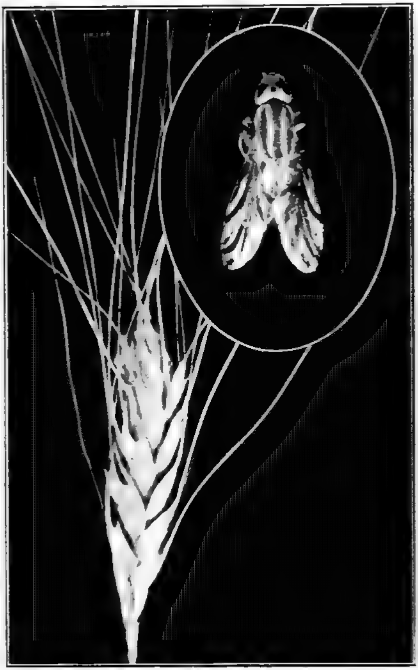

FIG. 113. — The Wheat-stem Maggot. Adult, enlarged, and work, natural size. Original.

The first generation of flies emerge in early summer from the young plants. Their offspring are the brood of maggots that cause the blanched heads.

The adults of these maggots emerge after normal threshing time, and there follows a midsummer generation on volunteer grain or wild grasses. Adults from these lay eggs on fall wheat or native grasses, and the maggots from these survive the winter, completing growth in the spring. On fall wheat they injure the base of the plant.

Prompt threshing and stacking will kill many of the insects in the ripe straw, and bury the survivors in the stack where the flies cannot get out to go through the midsummer generation on grasses. Late sowing of fall wheat probably will help to some extent.

The Stalk Borer (*Papaipema nitela* Guen.)

The stalks of many kinds of plants, such as tomato, corn, oats, barley, and others, are attacked by a worm which bores into them from without, feeds within, and frequently bores out again, moving

to a neighboring stalk. The entrance and often the exit holes of the worms are evident, together with castings thrown out

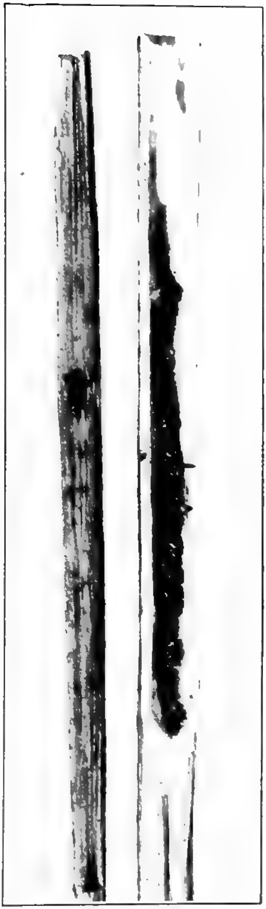

FIG. 114.—Work of the Stalk Borer. Original.

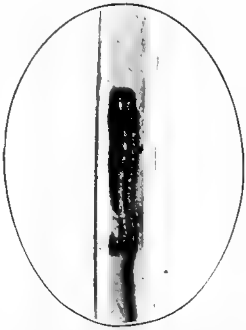

FIG. 115.—Stem cut open, showing larva of Stalk Borer at work. Original.

of the burrow, and the plant often wilts beyond the point of attack.

The full-grown larva measures about an

FIG. 116.—Adult of the Stalk Borer. Original.

inch in length. It is marked with five longitudinal stripes, but those on its sides are broken and wanting from the third to the seventh segments. The adult is a gray moth. Eggs are laid in the fall on the ground near suitable food plants, and hatch the next spring.

Certain weeds, especially burdock and ragweed, are the native food plants. Control consists in cutting and promptly destroying such weeds in or near the crops or plants attacked. The only direct measures feasible are removal of infested stalks as soon as the presence of the borers is discovered.

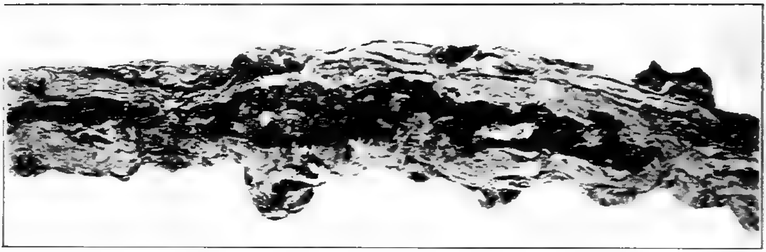

FIG. 117. — Work of the Squash Borer. Original.

The Squash Borer (*Melittia satyriniformis* Hbn.)

Whitish, fleshy grubs, about an inch long when full grown, bore in the stems of squashes and sometimes pumpkins or melons, often

FIG. 118. — Larva of the Squash Borer in stem of plant. Slightly enlarged. Original.

FIG. 119. — Cocoon and empty pupal shell of the Squash Borer. Original.

killing the part of the plant beyond them. Yellowish excrement will be found beneath the stem at the points where they are at work.

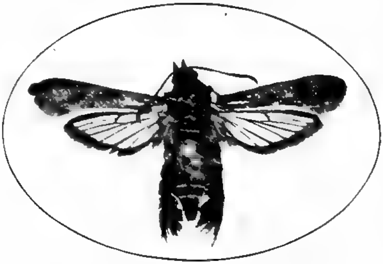

Fig. 120. — Adult of the Squash Borer. Slightly enlarged. Original.

Eggs are laid on the vines by the adults in early summer. The parent is a handsome moth. There is one generation in the north, but usually two in the south. The larva enters the ground to pass the winter.

If early varieties are planted as traps, the moths will lay on them rather than on winter varieties. All vines should be gathered and burned as soon as mature. Fall cultivation followed by deep spring plowing will kill many of the larvæ in the soil or prevent the moths from emerging. Moist earth drawn over the vines at joints will induce the formation of additional roots, enabling the plant to withstand attack. The vine may be slit and the borers removed.

Fig. 121. — Work of the Potato Stalk-borer. Original.

The Potato Stalk-borer (*Trichobaris trinotata* Say)

The potato stalk-borer is a small, yellowish-white grub, half an inch long, which bores in the

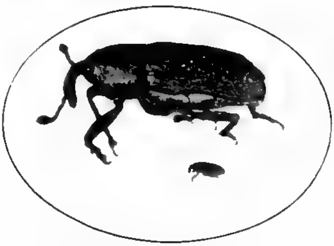

Fig. 122. — Adult of the Potato Stalk-borer. Enlarged and natural size. Original.

stalks of potato plants, frequently killing the vines. Its work is evident usually in midsummer. The adult is a gray snout beetle, with three black spots at the hind end of its thorax. It lays eggs just under the surface of the vines, and the grubs work beyond the reach of poison. Fortunately, the adults remain in the stalks over winter, and the pest is easily checked for the next season by removing and destroying the vines as soon as the crop of potatoes is harvested. Neighboring weeds also should be destroyed.

The Lima Bean Stem-borer (*Monoptilota nubilella* Hulst)

FIG. 123.—Work of the Lima Bean Stem-borer. Original.

In a few sections in the South the stalks of lima beans are attacked by a borer, which burrows inside and causes the formation of characteristic galls. The worm is bluish green, and nearly an inch long when full grown. There are probably two generations in the southern part of the insect's range.

Winter is passed as larva or pupa in the soil. Fall plowing and cultivation will help to suppress the insect. If stems showing the galls of the first generation are removed and destroyed, the numbers of the second generation should be materially reduced.

The Hop-plant Borer (*Hydrœcia immanis* Grt.)

FIG. 124.—Work of the Hop-plant Borer. Original.

The hop-plant borer feeds at three different points in or on the vines in the course of its

existence. Early in the season it bores inside the growing tips, causing them to turn down. It is now a slender green worm, marked with black dots. Soon it drops from the tips, enters the vine near the ground, and bores within at this point. At this stage it is reddish in color, dotted with black, and three fourths to an inch in length. After two or three weeks, it bores down and out, and feeds beneath the ground, just above the old roots, sometimes nearly cutting the vine off. It now reaches a length of two inches, is thick bodied, whitish, and marked with fine brown dots.

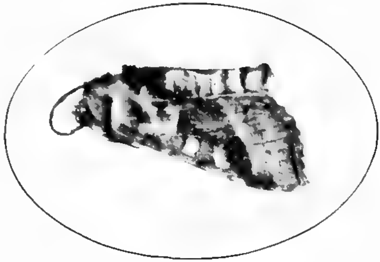

FIG. 125.—Adult of the Hop-plant Borer. Original.

A pupal stage is passed in the soil. Some of the adults emerge in the fall and some in the spring.

Tips showing the work of the earlier stage should be pinched off and destroyed. The grubs working in the soil may be driven deeper to the old roots by pulling away the dirt for a few days, later heaping ashes around the vines. On the old roots they will do little damage.

The Cabbage Curculio (*Ceutorhyncus rapæ* Gyll.)

A small snout beetle appears on cabbage plants early in the season, usually while the plants are still in the seed bed. The beetle is one eighth of an inch long and varies in color from gray to black. Its body is quite broad. Eggs are laid in the stalks, and a whitish grub tunnels within. Infested plants may droop over in their upper half, or break off in transplanting. The grub is full grown in three weeks, transforms in the soil, and the adults emerge a week later, disappearing after a few days. There is one generation annually.

Various wild plants, especially hedge mustard and wild peppergrass, are native food plants and are preferred to cabbage. Use may be made of these as traps, destroying them as soon as the beetles have laid their eggs in them. An application of arsenate of lead or Paris

green to the cabbages in the seed bed likely will serve to poison enough of the adult beetles to reduce injury by the grubs.

The Asparagus Miner (*Agromyza simplex* Loew)

Irregular mines are made just beneath the outer skin of asparagus stems. Frequently the surface will become ruptured and turn back, and beneath may be seen the tiny brown puparium, looking like a flaxseed. The larva which causes the injury is a footless maggot one fifth of an inch long, white, tapering to the head end. The adult is a small fly, rather hump backed, with a large head and prominent eyes.

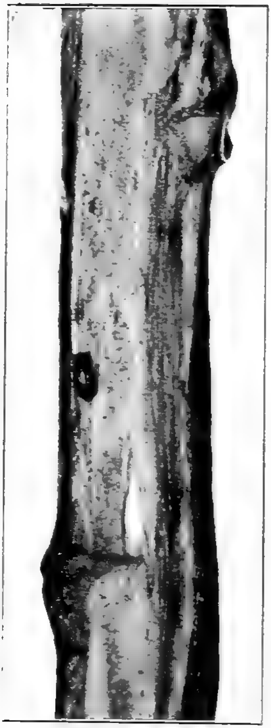

Fig. 126. — Work and puparium of the Asparagus Miner. Enlarged. Original

Fig. 127. — Adult of the Asparagus Miner. Enlarged and natural size. Original.

Badly infested stalks should be cut off or pulled up, and burned. Stalks that are being cut regularly for market will not show injury. A few plants may be left at this time as traps, and these destroyed.

The Rhubarb Curculio (*Lixus concavus* Say)

The stems of rhubarb sometimes are scarred and punctured by a snout beetle,

three fourths of an inch long. It may be controlled by hand picking. The normal place of breeding is in the stems of dock, and this weed should be removed from the neighborhood of rhubarb.

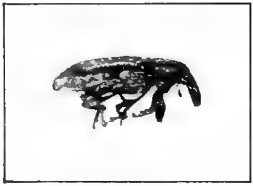

FIG. 128. — The Rhubarb Curculio. Slightly enlarged. Original.

The Hessian-fly (*Mayctiola destructor* Say)

Few insects have wrought greater damage than this pest in its periods of abundance. It is one of the prime enemies of our wheat-growing regions.

The adult is a tiny, two-winged gnat, one tenth of an inch long. It emerges in the fall, at the time that winter wheat is just unfolding its leaves, and lays eggs on the upper surface of the leaves. The resulting maggot goes down to a point within the leaf sheath, feeds, and later transforms to a small, hard, brown object looking like a seed, and known as the "flaxseed." In spring a new lot of adults emerge from these "flaxseeds," and at once lay eggs on the leaves of the young wheat as before. The maggots which hatch from these eggs feed at the base of the leaf, causing characteristic injury. An infested plant is stunted, shows no visible stem, and is darker than normal in color. If the infestation is severe, the plant is seriously injured or entirely destroyed. The summer is passed in the flaxseed stage, in the wheat stubble.

FIG. 129. — Work and puparia of the Hessian-fly. Original.

FIG. 130. — Adult of the Hessian-fly. Enlarged and natural size. Original.

In the spring wheat sections the life history is similar, except that winter is passed as a flaxseed in the stubble, and there are two generations in quick succession in summer.

No direct remedies are known. Crop rotation is of some value, but the adults can fly and thus infest new fields. The most effective plan is to delay planting of wheat in the fall for 10 days to two weeks beyond the usual time. The young wheat plants will then not be above ground or of suitable size when the adults emerge, and usually injury is largely averted.

Cutworms (*Noctuidæ*)

About the time that young plants in gardens are pushing through the soil they are found cut off even with the surface of the ground,

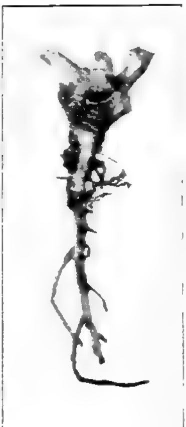

Fig. 131.—Work of Cutworms. Original.

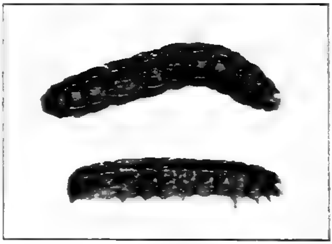

Fig. 132.—Larvæ of *Noctua clandestina*. Original.

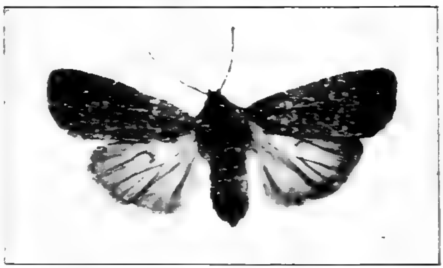

Fig. 133.—Adult of *Noctua clandestina*. Original.

the wilted top usually lying near the beheaded root stalk. Corn and other field crops suffer the same fate. As a rule the worms themselves are nowhere to be seen; but if one removes the soil to a depth of an inch or two near a dead plant, one will likely find a dark, naked worm, lying curled up and motionless.

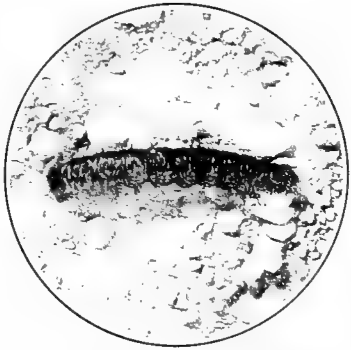

Fig. 134. — Larva of *Agrotis ypsilon*. Original.

There are many species. The worms differ in markings, but their work is much the same. They are the larvæ of night-flying moths of the family *Noctuidæ*. Their parents are on the wing in July and August, laying eggs in fields that are grown up to herbage of almost any kind. A field that has been allowed to run to weeds is favorite ground. The young worms that hatch from these eggs feed for a few weeks in the fall, and then hibernate in the soil. In the spring they resume activity, and after the ground has been plowed and seeded, they are ready to destroy the first green plants that show up.

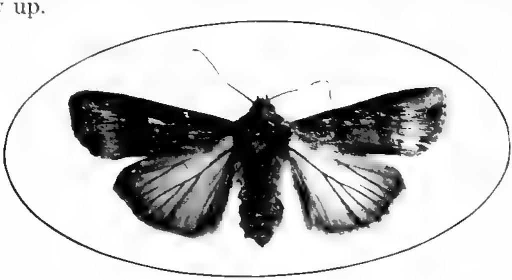

Fig. 135. — Adult of *Agrotis ypsilon*. Original.

In large areas, cultivate thoroughly in late summer, keeping the ground free of weeds, and plow deeply in the fall, following this with early cultivation in the spring.

FIG. 136. — Adult of *Noctua c-nigrum*. Original.

In the garden injury may be avoided by the use of poison bran mash in the spring, scattering it over the ground before the plants are due to come up. The worms will then be killed before they have done any damage. Tomatoes, cabbages, and other large plants may be protected by fitting a collar of paper around the stem, setting it two or three inches into the ground, and letting the upper edge be three or four inches above the surface.

Grasshoppers (*Acrididæ*)

Grasshoppers have been at times among the most destructive of pests on American farms. Almost every season finds them in excessive abundance and seriously injuring crops in some one of the states. At least half a dozen species have records of periodical devastation, but all are of such characteristic form, and their life histories are so similar, that it is unnecessary to attempt to recognize the various species.

FIG. 137. — Adult of *Melanoplus femur-rubrum*. Original.

The young appear early in summer. They have no wings, and are quite small, but otherwise they are much like the adults. They reach the winged stage in midsummer or later. Eggs are laid in the ground in pod-shaped masses, an inch or so below the surface. Pasture land, lanes, or places in undisturbed, close-growing vegetation of any kind are chosen for egg laying. Frequently large numbers are laid in alfalfa. The insect remains in the egg stage over winter,

When the insects have been abundant, all suitable breeding places should be deeply plowed in the fall. Alfalfa may be disked. In gardens or similar locations poison bran mash may be used, if poultry can be kept out.

In field crops two methods of direct control are in general use. The insects may be poisoned, or they may be caught in so-called "hopper-dozers." For wholesale poisoning a fairly satisfactory substance is the home-made material known as the Criddle mixture. Take five pails of horse manure, dissolve two pounds of salt in a pail of water and stir in one pound of Pairs green or London purple, and moisten the manure with this. Scatter it broadcast through the field. Another and an effective material is poison bran mash.

Fig. 138.—Adult of *Camnula pellucida*. Original.

The hopper-dozer consists of a long, shallow, sheet-iron pan, the bottom covered with wet carpet or burlap and liberally dosed with kerosene. Along the back of the pan is fixed a shield of canvas about three feet high, and this also is wet with kerosene. The pan is drawn sidewise over the ground by a man at each end, or by horses. The grasshoppers jump as the pan reaches them, come in contact with the kerosene in the pan or on the shield, and are killed by it. The scheme is satisfactory only if put into use while the insects are still in their wingless stages.

Certain species of grasshoppers develop the habit of migrating when excessively abundant. In such cases direct remedial measures are practically impossible.

Blister-beetles (*Meloidæ*)

Swarms of rather large, long-legged beetles, black, gray, or striped black and yellow, with distinct heads and "necks" and elongated, straight-cut bodies, sometimes descend on field or garden crops and

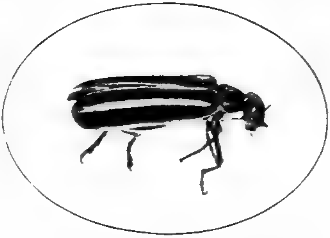

FIG. 139. — The Striped Blister-beetle. Original.

FIG. 140. — The Ash-gray Blister-beetle. Original.

quickly destroy the foliage. They often do great damage to sugar beets, potatoes, and beans, or other legumes. There are several species, as noted below.

The younger stages are spent in the soil, the larvæ feeding in the

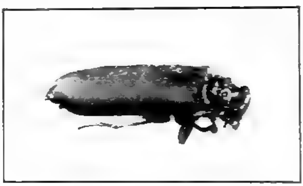

FIG. 141. — Nuttall's Blister-beetle. Original.

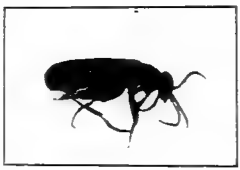

FIG. 142. — The Black Blister-beetle. Original.

egg clusters of grasshoppers. Emergence of the adult beetle takes place in the spring.

The Striped Blister-beetle (*Epicauta vittata* Fab.) is black, marked with three distinct, longitudinal yellow stripes. It is common on potatoes and sugar beets, but often attacks other crops.

The Ash-gray Blister-beetle (*Macrobasis unicolor* Kby.) is a smooth

gray in color. It is oftenest found on legumes, and sometimes on potatoes.

The Gray Blister-beetle (*Epicauta cinerea* Fors.) is of the same general type.

Nuttall's Blister-beetle (*Cantharis nuttalli* Say) is a handsome, shining, deep blue in color and the largest species of the group. It ranges through the Western states, and is especially destructive on beans and other legumes.

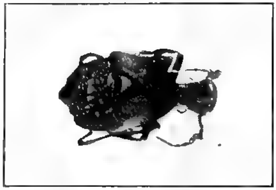

Fig. 143. — The Buttercup Oil Beetle. Original.

The Black Blister-beetle (*Epicauta pennsylvanica* DeG.) is often destructive to potato vines. It is a shining black in color.

The Buttercup Oil Beetle (*Meloe angusticollis* Say) is injurious for brief periods. It is a deep, shining, blue black in color, and has shortened wing covers. Often the abdomen is greatly enlarged.

Blister-beetles may be poisoned by prompt and thorough applications of Paris green or arsenate of lead, but they are apt to appear suddenly, and to do much damage before noticed. In field crops the beetles sometimes are driven away by a line of people armed with brush moving slowly across the field.

The Colorado Potato-beetle (*Leptinotarsa decemlineata* Say)

Potato-beetles or "bugs" need little description. For many years they have been omnipresent, and all who have raised potatoes or seen them growing will readily recognize the heavy-bodied beetle, three eighths of an inch long, with its yellow or orange wing covers marked with 10 black lines. (See frontispiece.)

The young or larva is often known as a "slug," and after the season is well started is found in large numbers on the vines. It is dark red, becoming lighter as it grows older, and has a series of black spots down each side. Its head is quite small. The eggs are bright orange, and are found in masses on the under side of the leaves.

The pest passes the winter as adult beetles under ground. They come

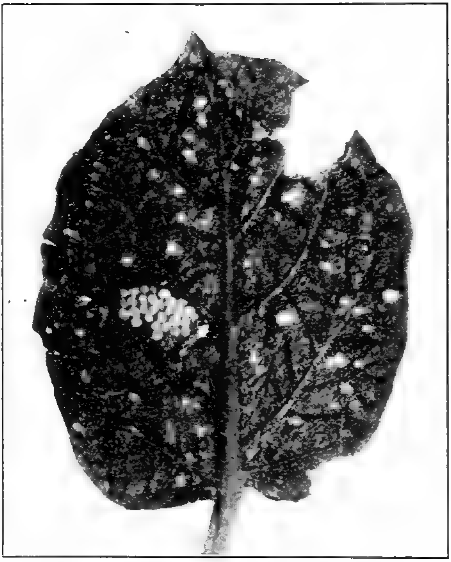

FIG. 144.—Eggs of the Colorado Potato-beetle. Slightly enlarged. Original.

out from these quarters early in the spring, and begin laying eggs as soon as food plants are available. Usually the over-wintering beetles live and continue laying eggs for a considerable period. The grub enters the ground to pupate, when it has become full grown. There are two generations annually.

Poisoning by means of Paris green and lime, or lead arsenate, is the simplest and best remedy. Use a rather heavy dose and apply early, as soon as the potato tops are a few inches high, repeating as needed.

The Three-lined Potato Beetle (*Lema trilineata* Oliv.)

FIG. 145.—The Three-lined Potato Beetle. Enlarged and natural size. Original.

Injury by this species is about the same as that done by the Colorado potato-beetle. The eggs are laid along the midrib of the leaf. The larva covers itself with a mass of excrement. The adult is a handsome beetle, its body striped with light yellow and black. Its length is a little more than one third of an inch. There

are two broods each season. The pest is easily killed by the application of Paris green or arsenate of lead.

The Larger Beet Leaf-beetle (*Monoxia puncticollis* Say)

Both the adult beetles and the larvæ feed on the leaves of beets. Injury is begun by the beetles, which are one fourth of an inch long, brownish to black in color, each wing cover vaguely marked with an obscure lighter band. Eggs are laid on the leaves, and from these hatch the larvæ, which add to the damage. The full-grown larva is one third of an inch long, rather robust, and nearly black in ground color. The segments are distinctly shown by low tubercles, the tops of which are marked with light yellow, giving the larva a dotted appearance. The insect appears to breed normally on native wild plants.

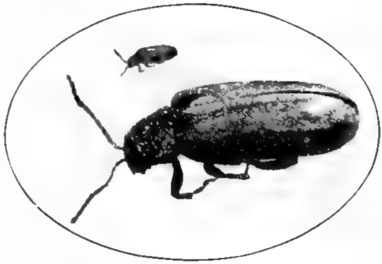

Fig. 146. — The Larger Beet Leaf-beetle. Enlarged and natural size. Original.

Its work may be checked by the prompt application of Paris green or arsenate of lead.

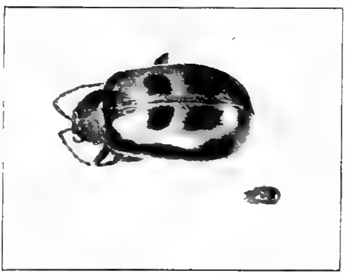

Fig. 147. — The Bean Leaf-beetle. Enlarged and natural size. Original.

The Bean Leaf-beetle (*Ceratoma trifurcata* Fors.)

Black and yellow beetles, one sixth of an inch long, feed on the foliage of beans, cowpeas, and related plants, eating holes in the leaves. The ground color of the insect is yellow or red, margined with black and with four black spots on its back. The larvæ live on the roots of the plants. The insect hibernates as an adult in any suitable shelter.

Prompt application of Paris green or arsenate of lead will check the pest. Apply early before the bean pods are well formed. Cleaning up rubbish in the fall is of value. The destruction of weeds that belong in the same botanical family is an additional remedial measure.

The Bean Lady Beetle (*Epilachna corrupta* Muls.)

In some of the Western states beans are subject to injury by this species. Early in the season the foliage is eaten by the adults, which have hibernated. These are followed by the larvæ, and later a new generation of adults is at work. As soon as the bean pods appear they are attacked as well as the leaves. The larvæ skeletonize the leaves, working on the under side, while the adults devour the leaf tissue entire.

FIG. 148. — The Bean Lady Beetle. Enlarged and natural size. Original.

The adult beetle is broadly oval, one third of an inch long, light brown in color, and marked with eight dots on each wing cover. The larva is about the same size, yellowish, and covered with short, branched spines. There is one generation annually.

Arsenicals, either Paris green or arsenate of lead, will kill both larvæ and adults. The applications must be made to the under side of the leaves.

The Squash Lady Beetle (*Epilachna borealis* Fab.)

Both the insect and its work are characteristic. The adult beetle is one third of an inch long, nearly as wide, yellowish to brownish in color, and marked with seven large black dots on each wing cover. In addition there are four small dots on the thorax. The eggs are yellowish, and are laid in clusters on the leaf. The larva is oval in shape, a half inch long, and covered with rather long, branching spines. The beetle marks out a circular area on a leaf and then feeds within this. The larva

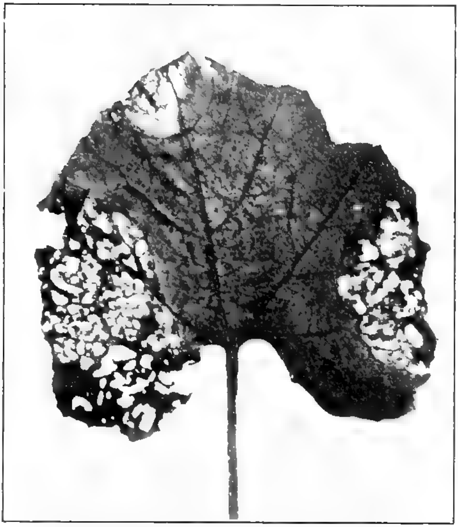

FIG. 149. — Work of the Squash Lady Beetle. Original.

FIG. 150. — Larva of the Squash Lady Beetle. Slightly enlarged. Original.

feeds anywhere on the leaf. Squashes and related plants are attacked. Winter is passed as an adult. There is one generation annually.

Eggs should be removed when found. Paris green or arsenate of lead may be used to poison the beetles and larvæ. With each of the last two species adults are at work both in spring and in summer because of the hibernating habits.

FIG. 151. — Adults of the Squash Lady Beetle. Original.

The Striped Cucumber Beetle (*Diabrotica vittata* Fab.)

As soon as the tender leaves of melons, cucumbers, and squashes are above ground, a lot of yellow and black striped beetles, two fifths of

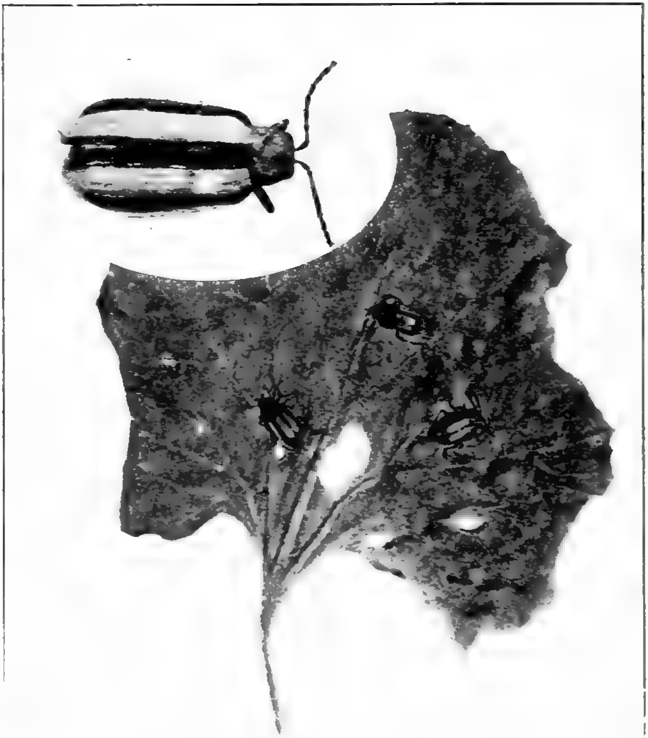

FIG. 152. — The Striped Cucumber Beetle. Adults, natural size and enlarged. Original.

an inch long, hunt them out and do their best to destroy them. The larvæ eat the tender roots of the same plants on which the adults are seen; and in addition the feeding of the adults is instrumental in spreading a bacterial wilt that often suddenly kills the vines.

There is one brood of this species in the North, but in the South two generations are recorded. The adults hibernate in any convenient shelter or in the ground.

Where possible, young plants should be protected with cloth or wire screen until they have got a start. Lacking this, it is wise to plant an excess of seed, thus allowing for the thinning that the pest will do.

It is difficult to poison the beetles, because they will hunt out parts of the stem or leaves, or later the inside of the flowers, where the sur-

Fig. 153. — Plants protected with cloth screens, to prevent injury by the Striped Cucumber Beetle. Original.

face is not coated with a spray material. Nevertheless, considerable protection is afforded by spraying thoroughly with arsenate of lead, using 4 or 5 pounds to 50 gallons of water.

Many repellents have been tried, but most are of little use when the beetles are numerous, and their effect seems to last only a short time. Probably the best is dry-slaked or air-slaked lime with which has been mixed flowers of sulphur. Fine road dust or tobacco dust will drive them away from the plants temporarily.

Beans or squashes planted ahead of the main crop will in a measure protect the latter. Removal of crop remnants, and general cleaning up of the garden in the fall, will help to avert serious injury the next season.

The Twelve-spotted Cucumber Beetle (*Diabrotica duodecimpunctata* Oliv.)

This insect, in its larval stage, is known in the South as the southern corn root-worm, where it is a pest of corn and other field crops.

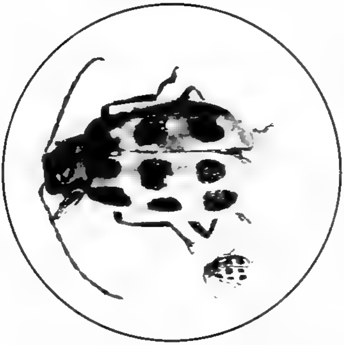

FIG. 154. — The Twelve-spotted Cucumber Beetle. Enlarged and natural size. Original.

In the central and northern regions injury by the adult beetle is more often noted, the crops attacked being cucumber, melon, squash, beets, cabbage — in fact, almost every sort of vegetable. The beetles are especially partial to the blossoming parts of the plant.

The adult is easily recognized. It is one fourth of an inch long, broader toward the hind end, yellowish green in color, and ornamented with twelve black spots on its back. Its head is black.

FIG. 155. — Eggs of the Asparagus Beetle. Enlarged and natural size. Original.

The adults hide away during the winter, and appear early in the spring. There are two generations in the North, and probably more in the South.

Remedies for the adult beetle are the same as those for the striped cucumber beetle.

The Asparagus Beetle (*Crioceris asparagi* Linn.)

Both the young shoots and the leafy tops of asparagus are attacked by the larva and the adult beetle of this species. The shoots are rendered unfit for use, and the injury to the tops weakens the plants.

The adult is one fourth inch long, blue black in ground color, its wing covers yellow, bordered and marked with dark blue, and its thorax red. It is active in habits, dodging around a stem when

Fig. 156. — The Asparagus Beetle. Larvæ and adults natural size, and adult enlarged. Original.

disturbed. The grub is three tenths of an inch long, grayish or olive, with a shining black head.

The beetles emerge from their hibernating quarters about the time that asparagus shoots are ready for the first cutting. Eggs are laid on the shoots, and later on the stems. The larva enters the ground

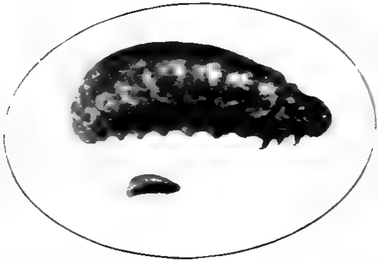

FIG. 157. — Larva of the Asparagus Beetle. Enlarged and natural size. Original.

to pupate. There are two to four generations annually.

To control, permit a few shoots to grow up at once, and poison with Paris green the beetles and grubs on these. Collect the shoots desired for the table or market at frequent intervals. Fresh, air-slaked lime dusted on the grubs will kill them.

The Twelve-spotted Asparagus Beetle (*Crioceris duodecimpunctata* L.)

Injury by this species to the young shoots is much the same as that due to the common asparagus beetle. Holes are dug and the surface is eaten both by the grubs and by the adult beetles. Later, when the tops are grown, the adults tend to feed largely on the substance of the berries.

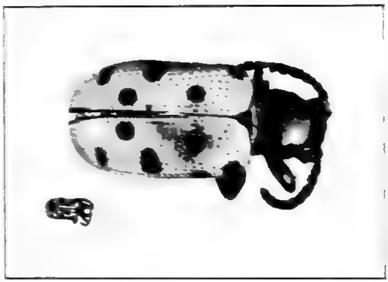

FIG. 158. — The Twelve-spotted Asparagus Beetle. Enlarged and natural size. Original.

The adult beetle is one fourth inch long, orange in color, with six black dots on each wing cover. The grub is three tenths of an inch long, with yellowish body and brownish head. There are from two to four generations annually.

Control is the same as that for the common asparagus beetle.

Tortoise Beetles attacking Sweet Potatoes

As soon as sweet potato plants are set out in the field they are sought out by odd little insects known as tortoise beetles. Holes are eaten

in the leaves, and when the young or larvæ get to work a few days later, the foliage may be pretty well destroyed.

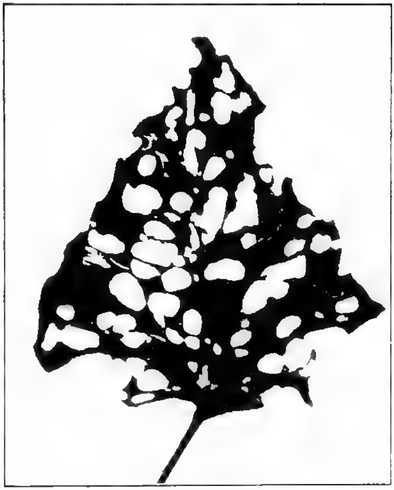

FIG. 159.—Work of Tortoise Beetles on sweet potato. Original.

The adult beetles are broadly oval, flattened, and their backs bear some resemblance to a tortoise shell. The Two-striped Sweet Potato Beetle (*Cassida bivittata* Say) is one fourth of an inch long, and has two black stripes on each of its yellow wing covers. The Golden Tortoise Beetle (*Coptocycla bicolor* Fab.) is larger and a bright, golden yellow. The Black-legged Tortoise Beetle (*Cassida nigripes* Oliv.) is five sixteenths of an inch long, and has gold wing covers, each bearing three black spots.

The larvæ of tortoise beetles are known as "peddlers," because they often carry a mass of excrement on two spines at the hind end, and elevate this over their backs.

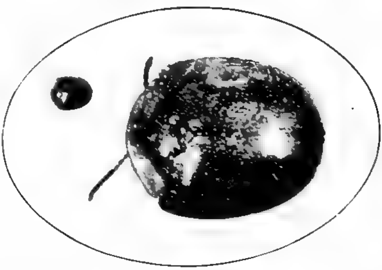

FIG. 160.—A Tortoise Beetle, *Coptocycla bicolor*. Enlarged and natural size. Original.

There is one generation a year. The adults hide away in warm, dry places. To control, dip the plants before setting out in arsenate of lead 1 pound to 8 or 10 gallons of water. The larvæ may be killed by applying Paris green or arsenate of lead to the plants after setting.

The Cucumber Flea-beetle (*Epitrix cucumeris* Harr.)

Synonyms: **The Potato Flea-beetle; The Tomato Flea-beetle**

The leaves of potatoes and tomatoes, and sometimes those of cucumbers and related plants, are riddled by very small, black, active beetles which quickly jump and disappear when disturbed. Their

Fig. 161. — The Cucumber Flea-beetle. Adults and work on potato leaf, natural size, and adult enlarged. Original.

work gives the leaf the appearance of being shot full of small holes, though frequently only the upper surface is eaten off at each feeding place. The beetle is so small that its markings can be made out only under a hand lens. It measures one sixteenth of an inch long, is quite black, and has yellowish legs and antennæ.

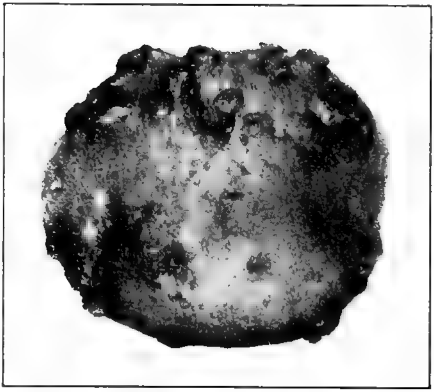
FIG. 162. — Potato injured by larvæ of the Cucumber Flea-beetle. Original.

The larvæ are very slender, tiny worms, and live in the soil, feeding on the roots. When numerous on potatoes, they may cause the surface of the tubers to develop raised spots or "pimples."

The adults hibernate in rubbish. Their first generation is raised on weeds related to the potato, such as horse nettle and the like. There are two or three broods in a season.

Bordeaux mixture combined with Paris green or arsenate of lead and applied as a spray is the best remedy. It will drive away most of the beetles, and those that remain will be poisoned.

The Pale-striped Flea-beetle (*Systena tæniata* var. *blanda* Say)

The common name well describes this species. The adult is one eighth inch long, its thorax cream colored, and its wing covers striped with the same shade, alternating with yellow.

Practically every kind of garden or field crop is attacked, including sugar beets, corn, tomatoes, melons, cabbages, turnips, cotton, and many others. The foliage of the plants is riddled with fine holes.

The larvæ feed on the roots of common weeds. The pest passes the winter as a rule in the larval stage, the adults appearing in large numbers in the early part of summer. There is one brood annually.

Where feasible, apply arsenicals to the plants attacked, or Bordeaux mixture combined with arsenicals. Weeds should be destroyed in the fall.

The Banded Flea-beetle (*Systena tæniata* Say) is similar in appearance, though darker, and of the same habits.

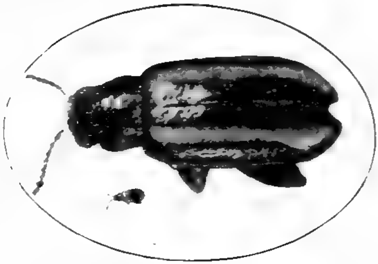

Fig. 163. — The Pale-striped Flea-beetle. Enlarged and natural size. Original.

Fig. 164. — Work of the Banded Flea-beetle. Original.

The Striped Flea-beetle (*Phyllotreta vittata* Fab.)

Cabbage, turnips, and related crops are preferred by this species of flea-beetle. The adults make numerous small holes in the leaves, and the slender, whitish larvæ live in the soil, feeding principally on the roots of various weeds of the same family. The adult is one eighth of an inch long, black, each wing cover marked with a light, waving band.

Fig. 165. — The Striped Flea-beetle. Enlarged and natural size. Original.

Paris green or arsenate of lead, either alone or in combination with Bordeaux mixture, may be used on turnip tops, or on cabbage that is not ready for market. On cabbage, until it is half-grown, add resin soap to the Paris green. After the plants are three fourths grown use repellents.

The Western Cabbage Flea-beetle (*Phyllotreta pusilla* Horn.)

This species is related to the preceding, and follows it closely in life history and habits. The adult is one twelfth of an inch long, dark green in color, without bands or other similar markings on its wings. Control is the same as for the preceding species.

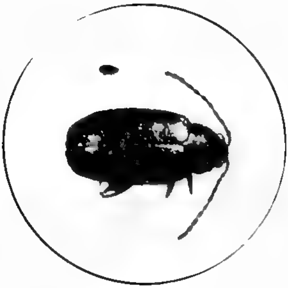

FIG. 166.—The Western Cabbage Flea-beetle. Enlarged and natural size. Original.

FIG. 167.—The Tobacco Flea-beetle. Enlarged and natural size. Original.

The Tobacco Flea-beetle (*Epitrix parvula* Fab.)

A small, dark, active beetle, provided with strong hind legs that enable it to jump readily, injures the leaves of tobacco both in the seed bed and in the field by eating numerous small holes in them. If one of the beetles be examined closely, it will be found to have a darker band across its back, and its wing covers are finely pitted.

The adults appear from their winter hiding places early in the spring. Eggs are laid on the ground or on the plants. The larvæ live in the ground, feeding on small roots.

Seed beds that are closely covered with cloth will not be injured. The adult beetles may be killed by thorough spraying with arsenate of lead or Paris green.

The Spinach Flea-beetle (*Disonycha xanthomelæna* Dalm.)

A much larger species of flea-beetle commonly attacks spinach, and is often a serious pest of sugar beets. The adult is one fourth of an inch long, with yellow thorax and shining blue wing covers.

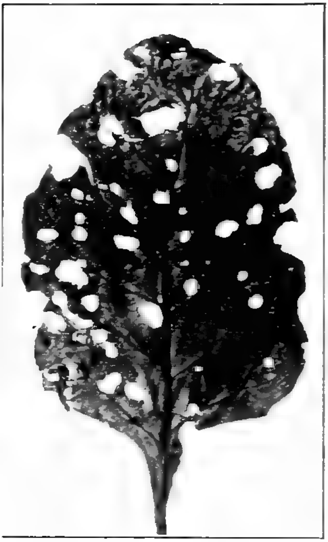

Fig. 168. — Work of the Spinach Flea-beetle. Original.

The larvæ of this species feed on the leaves. They are one fourth inch long when mature,

Fig. 169. — The Spinach Flea-beetle. Enlarged and natural size. Original.

rather thick bodied, grayish in color or sometimes dark purplish. On each segment are rows of raised tubercles. There are two broods in the course of the summer, the adults hibernating. The use of Paris green to poison the larvæ and adults, and the destruction of weeds in the fall and spring, are the remedies.

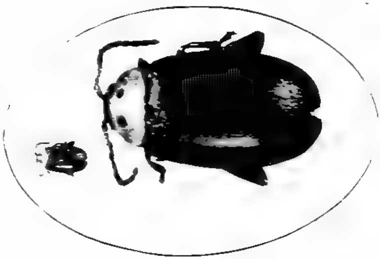

Fig. 170. — The Triangular Flea-beetle. Enlarged and natural size. Original.

The Triangular Flea-beetle (*Disonycha triangularis* Say) is about the same size as the preceding, and has the same feeding habits. Its thorax is marked with three black dots arranged in the form of a triangle.

The life history is similar to that of the preceding, and the same remedies will apply.

The Sweet Potato Flea-beetle (*Chætocnema confinis* Cr.)

Soon after sweet potato plants are set in the field they begin to show the characteristic work of the sweet potato flea-beetle. Narrow lines are gouged out on the surface of the leaf, at first following parallel to the veins, but later running in any direction. At the same time the beetles themselves will be noticed in increasing numbers. They are tiny, active, bronze-colored insects, one sixteenth of an inch long.

Fig. 171.— Work of the Sweet Potato Flea-beetle. Original.

Fig. 172.— The Sweet Potato Flea-beetle. Enlarged and natural size. Original.

In three or four weeks the beetles practically all disappear, having migrated to wild plants of related species. The only injury is at the beginning of the season.

Dip the plants in arsenate of lead when setting them out, immersing the tops but not the roots. Use 1 pound of lead arsenate to 8 or 10 gallons of water. In addition, spray the plants with arsenate of lead about ten days later, to protect new foliage. Plants that are set out late will escape serious injury.

The Hop Flea-beetle (*Psylliodes punctulata* Melsh.)

Leaves of hops, sugar beets, and some other plants are attacked by very small, active beetles, which feed at first on the tender shoots and buds and later eat holes in the leaves. The adult is about one tenth of an inch long, shining black, its upper surface marked with many minute pits in regular rows.

The larva is slender, whitish, and lives in the ground. There are two generations in the hop regions of the north Pacific coast. The insect hibernates as an adult.

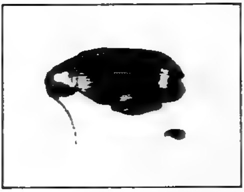

FIG. 173. — The Hop Flea-beetle. Enlarged and natural size. Original.

On sugar beets control is not easy. Bordeaux acts as a fairly effective repellent. A fair proportion of beetles may be poisoned by applying arsenicals.

Where the beetles appear suddenly in destructive swarms on hops, their numbers may be reduced materially by brushing them from the vines and catching them on sticky shields made by stretching cloth over light frames and coating the surface with tar. Banding the vines and poles with tanglefoot before the adults first appear will largely protect the vines, since the adults seem to follow the habit of crawling up the vines instead of flying.

The Alfalfa Leaf-weevil (*Phytonomus posticus* Fab.)

Alfalfa throughout the Western states is seriously threatened by this pest, which is native to Europe and Asia and has accidentally been introduced into this country.

The plants are injured both by the adult weevils and by their young or grubs. Depredations begin in early spring, when the beetles come out from their winter quarters and puncture the young stems of alfalfa to make places for depositing their eggs. Shortly the grubs hatch and begin feeding on the tender leaves and the crown of the plant. Transformation to the adult stage begins in June, and later the beetles

swarm on the plants, eating the freshly expanded leaves and gnawing the surface of stems in such way as to kill the growth above.

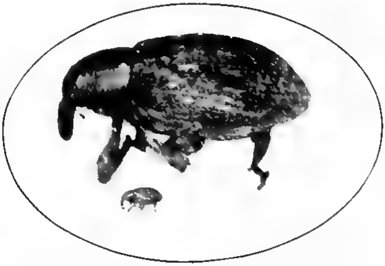

FIG. 174. — The Alfalfa Leaf-weevil. Enlarged and natural size. Original.

FIG. 175. — Pupa of the Alfalfa Leaf-weevil. Enlarged and natural size. Original.

The adult is one eighth to three sixteenths of an inch long, and when freshly emerged is brown. It grows darker in a few days. Its body is covered with black and gray hairs, giving it a mottled appearance. The grub is one fourth inch long, tapering toward each extremity, and has a light stripe down its back.

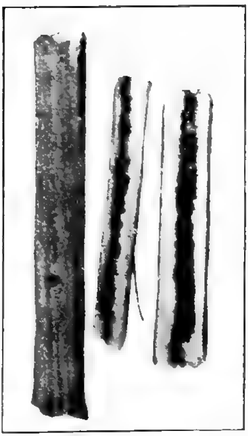

FIG. 176. — Egg puncture and work of the Alfalfa Leaf-weevil. Original.

FIG. 177. — Feeding punctures of the Alfalfa Leaf-weevil. Original.

Remedial measures thus far devised include: thorough disking early in the spring so as to induce quick, vigorous growth of the plants; the use of a spike-tooth harrow combined with a brush drag immediately following the first cutting

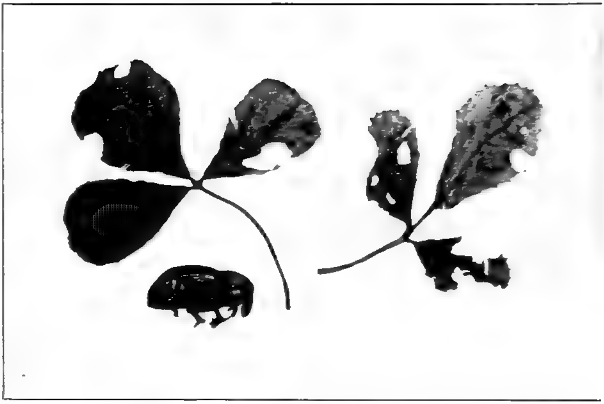

FIG. 178.—The Clover Leaf-weevil. Work on clover leaves. Adult enlarged to twice natural size. Original.

of hay, so as to knock off and kill the grubs; breaking up old alfalfa fields, not allowing a field to remain more than six years; and scrupulous cleaning up of all rubbish or other hiding places in the fall.

The Clover Leaf-weevil (*Phytonomus punctatus* Fab.)

In early spring the leaves of clover and alfalfa show the

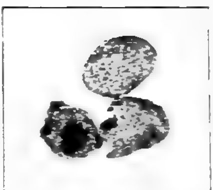

FIG. 179.—Cocoons of the Clover Leaf-weevil. Slightly enlarged. Original.

FIG. 180.—Clover head deformed by work of the Lesser Clover Leaf-weevil. Original.

characteristic work of the larvæ of the clover leaf-weevil. The grubs themselves are not apt to be seen, for they work only at night and lie concealed close to the base of the plant during the daytime, but the edges of the leaves will be found eaten out in regular scallops. The full-grown larva is a half inch long, dusky green, with a lighter stripe down the middle of the back.

FIG. 181. — Larva and work of the Lesser Clover Leaf-weevil. Original.

In July or August the adult beetle is to be found, feeding on the leaves of the plants. It is one third of an inch long, dark brown in color but lighter on the sides, and covered with short hairs.

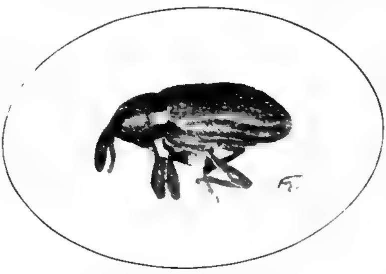

FIG. 182. — The Lesser Clover Leaf-weevil. Enlarged and natural size. Original.

Eggs are soon laid by the beetles, the young grubs feeding for a short time and then hibernating near the plants just below the surface of the soil.

No direct measures of control are feasible. Badly infested fields should be plowed and seeded to some other crop. Damage is seldom serious until a field has been in clover for two years.

FIG. 183.—Cocoon of the Lesser Clover Leaf-weevil in clover head. Enlarged. Original.

Large numbers of the grubs often die from a fungous disease, and may be seen coiled around the stems near the top. Cattle eating clover on which many of these dead larvæ are present, are apt to be mildly poisoned.

The Lesser Clover Leaf-weevil (*Phytonomus nigrirostis* Fab.)

Small holes are eaten in the young and tender leaves of clover, and later, at the blooming period, the inner parts of the heads are destroyed by a tiny grub, the immature stage of a small, greenish snout beetle.

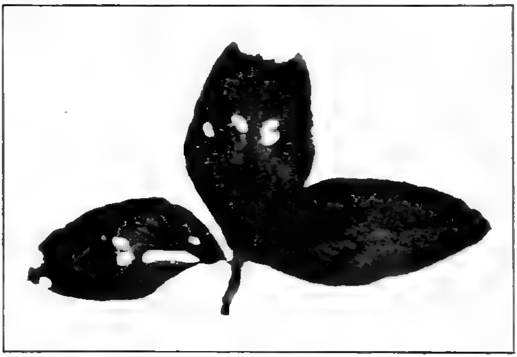

FIG. 184.—Clover leaves showing characteristic work of the Lesser Clover Leaf-weevil. Original.

The beetle spends the winter in rubbish or other shelter. Emergence begins with warm weather, and egg-laying continues for several weeks. There is only one generation annually.

No direct remedial measures are known.

The Flavescent Clover-weevil (*Sitones flavescens* Marsh.)

Occasionally the leaves of clover are eaten by a brownish snout beetle, three sixteenths of an inch in length, its body rather thickly covered with short hairs. The larvæ work in the softer parts of the stems. The insect hibernates as a larva. Dusting or spraying with Paris green or arsenate of lead will kill the beetles.

FIG. 185. — Work of the Flavescent Clover-weevil. Original.

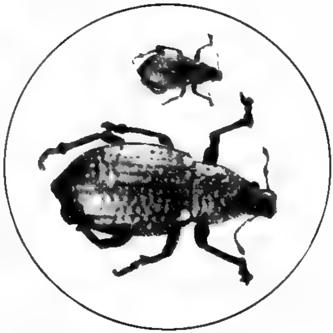

FIG. 186. — The Imbricated Snout Beetle. Enlarged and natural size. Original.

The Imbricated Snout Beetle (*Epicærus imbricatus* Say)

Practically all species of garden and field crops, and sometimes the buds or foliage of tree or bush fruits, may be attacked by this insect. It is a rather large snout beetle, five eighths of an inch long, its wing covers banded in zigzag pattern with gray and light brown. The snout is broad and short. The larva lives in the ground. The adults cannot fly.

The beetles may be poisoned by promptly applying arsenate of lead or Paris green.

FIG. 187. — Larva of *Phlegethontius sexta*. Original.

Tobacco or Tomato Worms (*Phlegethontius sexta* Joh., and *Phlegethontius quinquemaculata* Haw.)

Large, naked, green worms, armed with a curved horn near the hind end, eat the leaves of tomato and tobacco. There are two species. *P. quinquemaculata* has eight V-shaped, light-colored markings on

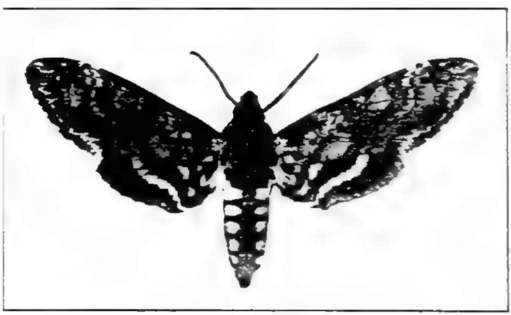

FIG. 188. — Adult of *Phlegethontius sexta*. Slightly reduced. Original.

each side of its body; *P. sexta* has only seven markings instead of eight, and these are merely oblique lines. Either form is found to some extent both North and South. The full-grown worm is often 3 inches long. The adult is a large, strong-flying moth, seen in evenings.

FIG. 189. — Pupa of *Phlegethontius sexta*. Slightly reduced. Original.

FIG. 190. — Pupa of *Phlegethontius quinquemaculata*. Slightly reduced. Original.

When the worm has completed its growth, it enters the soil to a depth of 4 or 5 inches, and makes a cell. In the South worms that mature early will emerge in the latter part of the same summer, thus giving a second generation. Emergence of the adult moths begins in June, but continues for fully two months. A large proportion of the adults emerge rather late than early, and the result is that worms are most numerous in August.

Hand picking is universally practiced. The worms may be poisoned by dusting lightly with Paris green or arsenate of lead. The moths may be killed by placing a few drops of arsenide of cobalt in the flowers of jimson, which they frequent. Prepare by mixing arsenide of cobalt,

FIG. 191. — Adult of *Phlegethontius quinquemaculata*. Slightly reduced. Original.

1 ounce, water 1 pint, and molasses or honey to sweeten. Fall plowing will kill large numbers of the larvæ in the soil.

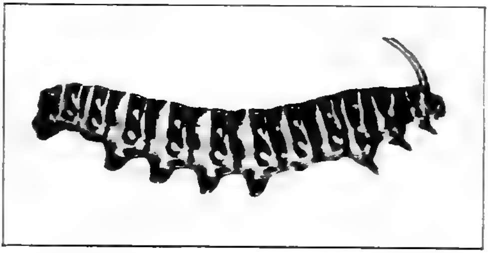

Fig. 192. — The Celery Caterpillar. Original.

The Celery Caterpillar (*Papilio polyxenes* Fab.)

Leaves of celery, parsnips, and other plants of the same family are eaten by a large, naked worm, bright green or yellow, and strikingly

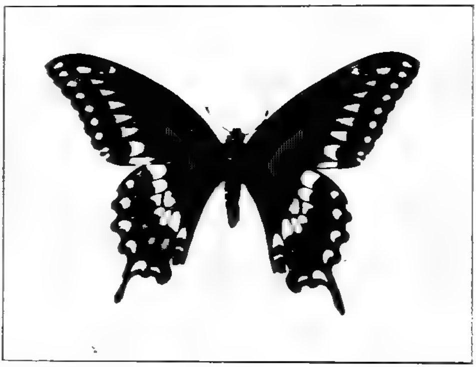

Fig. 193. — Adult of the Celery Caterpillar. Slightly reduced. Original.

banded with velvet black. The adult is commonly known as the black, swallow-tail butterfly. There are two generations in the North, and three or four in the Southern states.

Usually the worms are easily controlled by knocking them from the leaves and crushing them. When excessively abundant, they may be

killed by applying arsenicals, using either arsenate of lead or Paris green.

The Zebra-caterpillar (*Mamestra picta* Harr.)

A conspicuous, naked caterpillar, two inches or more long when full grown, feeds on garden crops of various sorts, especially beets,

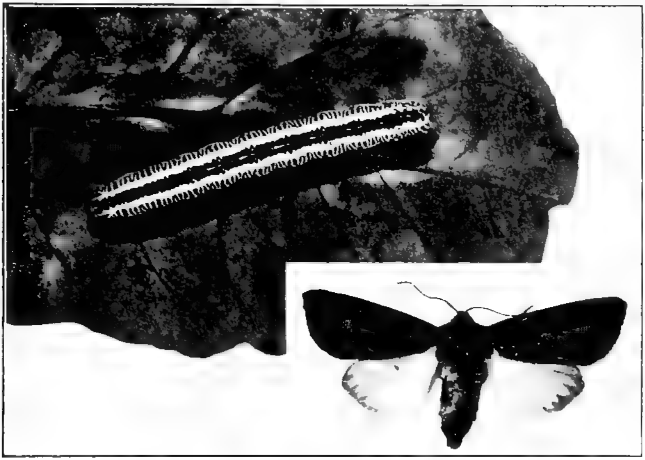

FIG. 194. —The Zebra-caterpillar. Larva and adult. Original.

spinach, celery, and peas. The body is yellow, with a black stripe down the back, and another down each side. The head is red. There are two generations, the first feeding in early summer and the second in the fall. The species hibernates as a pupa. Hand picking is the usual remedy, but they may be poisoned by liberal doses of arsenate of lead or Paris green.

The Striped Garden Caterpillar (*Mamestra legitima* Grote)

This species closely resembles the related zebra-caterpillar. It may be distinguished from the other by its darker color and the fact that the lateral stripes are divided into two portions, the upper lighter than the lower. The feeding habits, life round, and means of control are the same as for the zebra-caterpillar.

The Army Worm (*Leucania unipuncta* Haw.)

In occasional seasons naked, dull-striped worms, related to the common cutworms, become abnormally abundant, march from field to field, and devour corn, wheat, oats, and other related plants. Individuals of this species are in our fields every year, but we do not particularly note their presence until they reach their times of unusual abundance, abandon their normal habits of remaining concealed during daylight and feeding only at night, and in their search for food form the devastating "armies." The full-grown worm is about $1\frac{1}{4}$ inches long, dark in general color, with three yellowish stripes down its back and a stripe down each side. It is the younger stage of a dull, brownish moth.

Fig. 195. — Larva and work of the Army Worm. Slightly enlarged. Original.

Fig. 196. — Work of Army Worms on timothy heads. Original.

The winter is passed as half-grown larvæ in the ground. In the spring these larvæ transform, moths emerge, and in a few weeks another generation of worms is at work. It is this generation that is apt to reach such numbers as to prove a serious pest. In the North there are three broods in a season; in the South five or six. Normally the insect is held down to moderate numbers by its natural enemies.

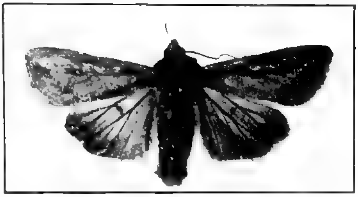

Fig. 197.—Adult of the Army Worm. Original.

When the worms reach excessive abundance and begin to travel from one field to another, invasion may be stopped by plowing three or four furrows, and maintaining a thick dust in these if possible. As worms collect in the furrows they may be killed with a drag, or by sprinkling them with kerosene or kerosene emulsion. Another measure sometimes advisable is to apply a heavy dose of Paris green to a strip a few yards wide on the side of the field that is threatened. Or poison bran mash may be used. It is advisable to plow in the fall fields in which the worms have been numerous in late summer, in order to destroy as many of the hibernating larvæ as possible.

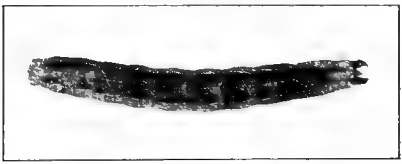

Fig. 198.—The Fall Army Worm. Slightly enlarged. Original.

The Fall Army Worm (*Laphygma frugiperda* S. and A.)

This species is related to the "army worm," but whereas the latter reaches its periods of occasional destructive abundance in the early summer months, the fall army worm becomes a pest in the latter part of the summer, usually in August. The full-grown worm is dark in color, about $1\frac{1}{2}$ inches long, and has a yellowish stripe down the middle of its back. Within this stripe, on each segment, are four

small dark dots. There is a rather dark stripe down each side of the body.

Frequently this species is abundant without developing the instinct of marching in "armies." It feeds on alfalfa, sugar beets, and many other field and garden crops. Winter is passed as pupa in the ground. There are two broods in the North; four in the South.

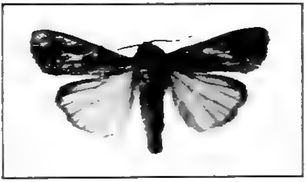

FIG. 199. — Adult of the Fall Army Worm. Original.

Control depends on the nature and extent of the crop attacked. In limited areas apply arsenicals. In large fields the worms may be killed by crushing them with a heavy roller. Fall plowing and disking, combined with cultivation where feasible, will kill many of the overwintering forms.

The Beet Army Worm (*Laphygma exigua* Hbn.)

In some of the Western states this species has periods of disastrous abundance on sugar beets. Its invasions occur at the same time as those of the fall army worm. The larva resembles the latter, but lacks the distinct black dots. On each side there is a dark stripe, along the lower edge of which is a series of white dots. The winter is passed as an adult moth. There are two broods in the summer, and apparently the normal food plants are certain weeds. Clean culture is indicated, in order to keep down the weeds on which the species may live in spring or fall. The worms may be poisoned by applying Paris green or arsenate of lead.

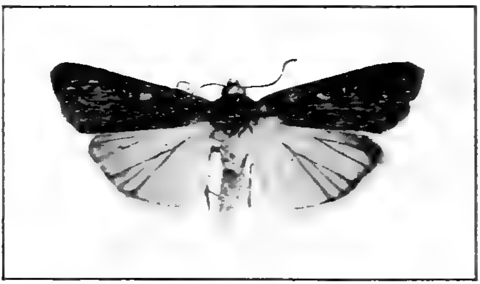

FIG. 200. — Adult of the Beet Army Worm. Slightly enlarged. Original.

The Cotton Worm (*Alabama argillacea* Hbn.)

Dark greenish caterpillars, striped with black, eat the leaves and tender shoots of cotton, attack beginning in a small way early in the season, and increasing as additional generations of the pest are developed. When quite small, the caterpillars are light green, marked with dark spots, and eat only the under surface of the leaf, but they soon change to the coloring noted above, and their work is extended to include all of the leaf tissue.

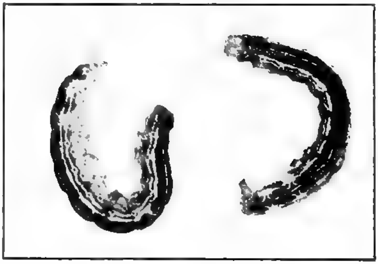

Fig. 201. — The Cotton Worm. Original.

The adult is a brownish moth expanding somewhat over an inch, and invades the Southern states, from Mexico, or points farther south. It is abundant only at rare intervals. Eggs are laid on the leaves, and the pupal stage takes place in a folded leaf on the plant. There are three to seven generations annually.

Fig. 202. — Adult of the Cotton Worm. Original.

The application of arsenicals to poison the worms is effective. The ordinary practice is to apply dry Paris green, dusting it on the plants by means of bags tacked to a pole.

The Alfalfa Caterpillar (*Eurymus eurytheme* Boisd.)

The leaves of alfalfa, and sometimes of other plants, are eaten by a dark green caterpillar, occasionally abundant enough to be destructive. The worm is naked, one inch long, has a white stripe down each side, obscurely broken by small red and black dots, and sometimes dark stripes down the middle of its back.

The adult is a yellow butterfly, expanding about two inches, its wings

bordered with black. In the southwest there are four generations annually.

Where attack is severe, fields should be mowed. Alfalfa that is pastured is much less liable to injury.

Fig. 203.—Adult of the Imported Cabbage Worm. Original.

The Imported Cabbage Worm (*Pontia rapæ* Sch.)

A velvety green worm, an inch to an inch and a half long, eats large, irregular holes in the leaves of cabbage or cauliflower, and disfigures the heads by deposits of excrement. When examined closely, the worm is seen to have a faint yellow stripe down the center of its back.

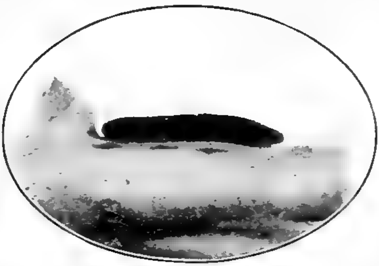

Fig. 204.—The Imported Cabbage Worm. Larva on leaf. Original.

The adult is the familiar white "cabbage butterfly," often observed hovering over fields of cabbage or cauliflower all through summer. There are from one to four or five broods, according to the section where found.

Arsenicals may be used safely on cabbages until they are half grown. An effective spray is Paris green to which has been added resin soap "sticker," so that it will not run off the leaves. Directions for making the resin soap mixture are given elsewhere in this book. Poison bran mash, as prepared for cutworms, is effective, and may be used safely until the plants are nearly full grown. Hellebore is available on plants ready for market.

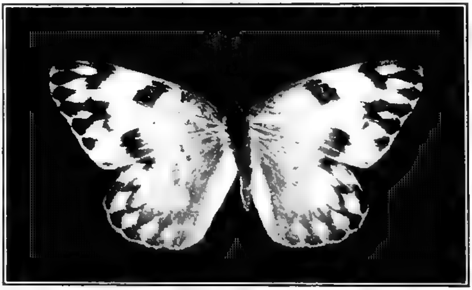

Fig. 205. — Adult of the Southern Cabbage Worm. Original.

The Southern Cabbage Worm (*Pontia protodice* Boisd.) is a closely related species with similar habits.

The Cross-striped Cabbage Worm (*Evergestis rimosalis* Guen.)

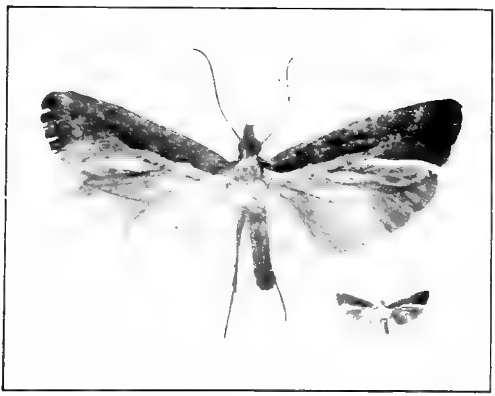

Fig. 206. — The Diamond-back Moth. Enlarged and natural size. Original.

The larva of this species is bluish in color, about three fifths of an inch long, and has numerous narrow stripes of black across its back. It feeds on cabbage heads in the same manner as the common cabbage worm. The adult expands about one inch, and is light yellowish, the margins of its wings marked with black or brown.

The normal range of this species is through the Gulf states and neighboring territory. Remedies are the same as for the imported cabbage worm.

The Diamond-back Moth (*Plutella maculipennis* Curt.)

Tiny active green worms, scarcely more than a quarter of an inch long when full grown, eat small holes in the leaves of cabbage, and occasionally become so numerous that notable damage is done. The adult is a delicate moth. There are two or three generations in the North, and half a dozen or more in the South.

The remedies given for the imported cabbage worm will readily hold this species in check.

The Cabbage Looper (*Autographa brassicæ* Riley)

At the same time that the imported cabbage worm is found feeding on cabbage heads this species is likely to be observed at similar mis-

FIG. 207. — The Cabbage Looper. Original.

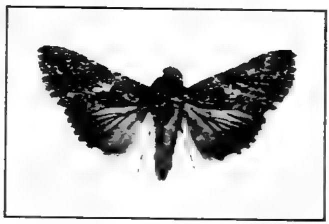

FIG. 208. — Adult of the Cabbage Looper. Original.

chief. It is a light green worm, with a faint whitish stripe down each side, and moves with a looping movement, often resting with the middle of its body elevated.

Remedies are the same as for the imported cabbage worm.

The Celery Looper (*Plusia simplex* Guen.)

Occasionally this species becomes abundant enough to be a pest, destroying the leaves of celery. It is a smooth-bodied caterpillar, and

moves with a looping gait. On each side of its body is a row of dark dots or rings. Hibernation takes place as a half-grown caterpillar. There are three broods annually. The pest may be checked by the use of arsenicals, preferably Paris green and lime, which can be washed from the leaves when the stalks are ready to use.

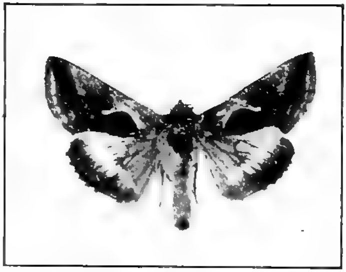

FIG. 209.—Adult of the Celery Looper. Original.

The Northern Grass Worm (*Drasteria erechtea* Cramer)

Clover and grasses sometimes are damaged by a fairly large "measuring worm," which eats the leaves. When full grown the worm is $1\frac{1}{4}$ inches long, striped with gray and brown, and has the habit of moving with a looping gait. It transforms in a nest made by drawing leaves together with silk. There are several generations in the course of a summer. The best means of control in periods of excessive abundance is fall plowing.

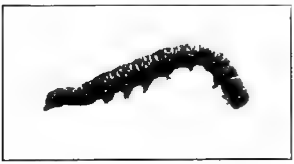

FIG. 210.—The Northern Grass Worm. Original.

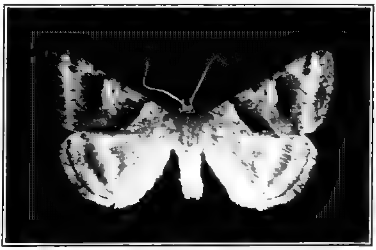

FIG. 211.—Adult of the Northern Grass Worm. Original.

The Hop Snout-moth (*Hypena humuli* Harr.)

The foliage of hops is attacked by green caterpillars an inch long when full grown. The body is dotted with black, there is a dark stripe

down the center of the back, bordered with lighter, narrow lines and a similar light line on each side of the body. When crawling, the caterpillar raises the body slightly in the middle. There are two broods annually, the first in spring and the second in midsummer. The species hibernates as an adult moth. Spraying with arsenicals will readily control the pest.

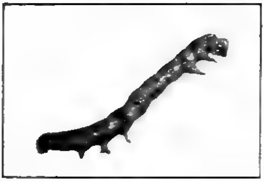

FIG. 212. — Larva of the Hop Snout-moth. Original.

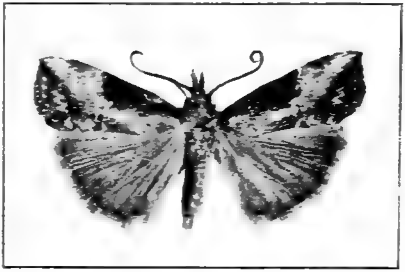

FIG. 213. — The Hop Snout-moth. Slightly enlarged. Original.

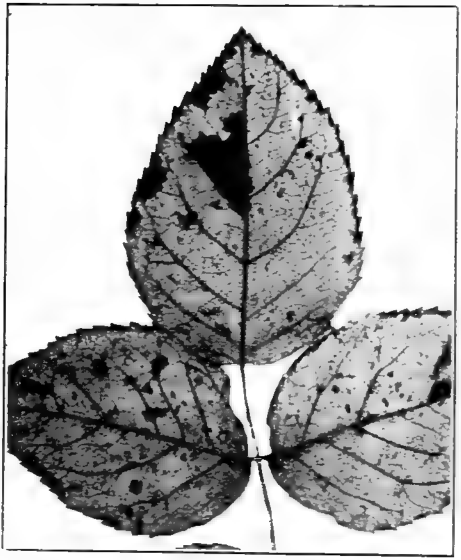

FIG. 214. — Work of *Endelomyia rosæ*. Original.

Sawflies on Wheat

Rarely the larvæ of two or three species of sawflies are found feeding on wheat, eating the leaves, gnawing into the stems, or cutting off the heads. In the species *Dolerus collaris* Say and *Dolerus arvensis* Say, the larvæ are dark gray, cylindrical, and have 22 legs. In the species *Pachynematus extensicornis* Nort., the larva is greenish, with a yellow head, and has 20 legs.

The pupal stage is passed in the soil. The only means of control available is deep fall plowing.

Rose Slugs

Three species of "slugs," the larvæ of sawflies, commonly infest the foliage of roses in this country. The surface of the leaves may be skeletonized, as with the native American species, *Endelomyia rosæ* Harr.; or holes may be eaten in the leaves, as with an imported species, the Bristly Rose Slug, *Cladius pectinicornis* Fourer; or the larva may attack the edge of the leaf, eating out large sections, as with another imported species, the Coiled Rose Slug, *Emphytus cinctus* L.

Either arsenate of lead or Paris green will readily poison the slugs. Or, they may be dislodged by a strong stream of water.

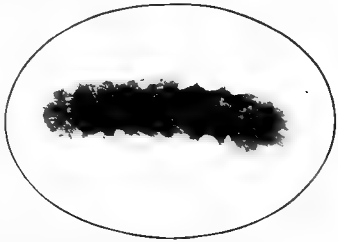

FIG. 215. — The Yellow-bear Caterpillar. Original.

The Yellow-bear Caterpillar (*Diacrisia virginica* Fab.)

Rather large and hairy caterpillars attack the leaves of a great variety of vegetables as well as many kinds of weeds. Usually they are not abundant enough to do serious injury. A full-grown caterpillar is 2 inches long. The hairs arise in tufts on the back and sides, and vary from light yellow to brown. The adult is a light-colored moth, expanding $1\frac{1}{2}$ to $1\frac{3}{4}$ inches, marked with a few small dark dots. There are two generations, the second lot of caterpillars appearing in August or September.

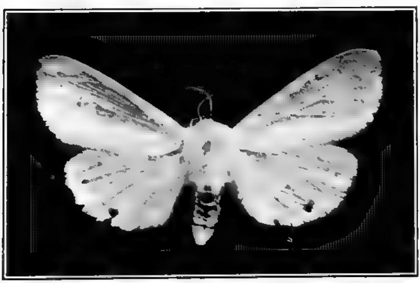

FIG. 216. — Adult of the Yellow-bear Caterpillar. Original.

Hand picking will suffice to control this insect when present in moder-

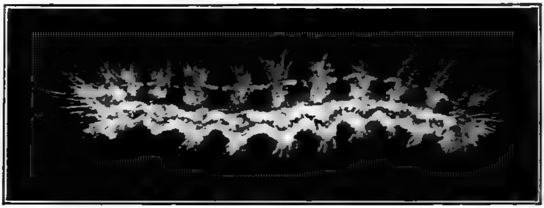

FIG. 217.—The Salt-marsh Caterpillar. Original.

ate numbers. When very abundant, spray with Paris green and lime, making the dose quite heavy as the caterpillars are resistant.

FIG. 218.—Adult of the Salt-marsh Caterpillar. Original.

The Salt-marsh Caterpillar, *Estigmene acræa* Dru., is another hairy caterpillar closely paralleling the above in appearance and habits. Its body is darker, and there are yellow markings on each side.

The Hedgehog Caterpillar, *Isia isabella* S. and A., is thickly covered with close-cropped soft hairs, brownish red along the middle of its body and black at either end.

FIG. 219.—The Hedgehog Caterpillar. Original.

Control of these two species is the same as for the yellow-bear caterpillar.

Neither is apt to be abundant enough to be a serious pest.

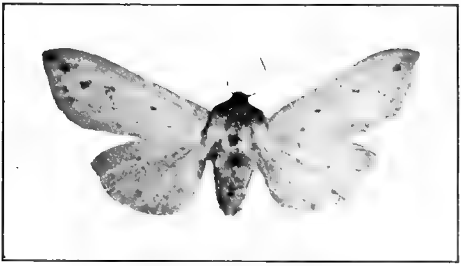

FIG. 220. — Adult of the Hedgehog Caterpillar. Original.

The Saddle-back Caterpillar (*Sibine stimulea* Clem.)

This is a short, broad caterpillar, distinctly spiny. There are two especially long spines at each end. The body is dark at either end, light green in the middle, and in the center of the green area is a dark, oval spot. The spines cause irritation if they come in contact with the skin. Care should be taken not to handle the caterpillar or to touch it inadvertently.

FIG. 221. — The Saddle-back Caterpillar. Original.

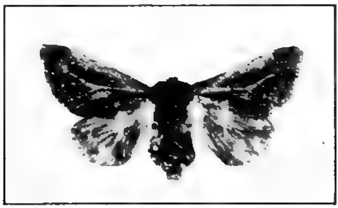

FIG. 222. — Adult of the Saddle-back Caterpillar. Original.

The Garden Webworm (*Loxostege similalis* Gn.)

Corn and cotton, and sometimes beets or garden crops, are invaded by hordes of yellowish worms, one half to three fourths of an inch long, marked with many small, dark dots. They spin webs over the plant and skeletonize the leaves. The pest appears early in the season, having migrated from pigweed, which is the normal food plant, or from alfalfa.

on which the first generation often is raised. There are from three to five generations annually. The adult is a yellowish moth, expanding three fourths of an inch. Winter is passed as larva or pupa in the soil.

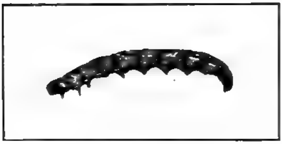

FIG. 223. — The Garden Webworm. Original.

In garden or small areas, the pest may be controlled by prompt application of Paris green or arsenate of lead. Fall plowing will help for the next season. Alfalfa should be well disked. No pigweed should be allowed to grow in or near the garden or field.

The Sugar-beet Webworm (*Loxostege sticticalis* Linn.)

The work of this species is practically identical with that of the garden webworm. Recently it has developed into a serious pest of sugar beets in some of the Western states. The larva is an inch long when full grown, brownish in color, with a narrow dark stripe edged with white down the middle of its back, and a light stripe down each side. There are numerous dots over the surface of its body. It webs up the foliage as it works.

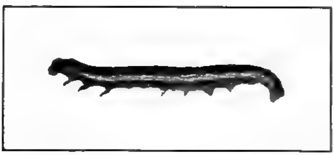

FIG. 224. — The Sugar-beet Webworm. Original.

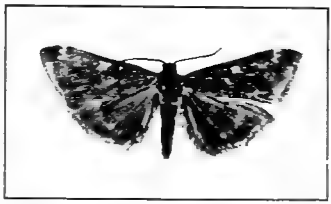

FIG. 225. — Adult of the Sugar-beet Webworm. Original.

Winter is passed in a silk cocoon in the soil. The moths emerge in the spring and lay eggs on the leaves of pigweed and alfalfa. There is a second generation in July and a third in August. It is the last that is usually most injurious to sugar beets.

Late fall plowing will break up the winter cells in the soil. Paris green or arsenate of lead may be used as a direct means of control. The poisons should be applied promptly, at the first sign of the presence of the pest.

The Southern Beet Webworm (*Pachyzancla bipunctalis* Fab.)

In the South a webworm, similar in habits to the common garden webworm, has been found feeding on beets. The full grown worm is three fourths of an inch long, slender, dark green in color. The adult is a yellowish moth, expanding one inch. There are at least four generations annually. To control, apply arsenate of lead or Paris green, either dry or as a spray, as soon as the worms are first observed. The poisons should be applied promptly to be effective.

The Cabbage Webworm (*Hellula undalis* Fab.)

In the Southern states cabbages, turnips, and related crops are damaged by a small, striped caterpillar, which spins webs in the leaves for

Fig. 226. — The Cabbage Webworm. Original.

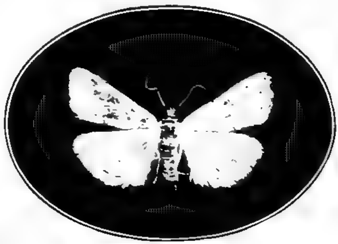

Fig. 227. — Adult of the Cabbage Webworm. Original.

shelter, feeding exposed, but retiring to the webs when resting. When full grown, the worm is half an inch long, yellowish in ground color, and ornamented with five narrow stripes down its body. Injury is most apt to occur in late summer, on young plants set out for fall crops. Arsenicals may be used to poison the caterpillars, since they are not hidden in their webs when feeding. Either Paris green or arsenate of lead is effective.

The Celery Leaf-tier, or **Greenhouse Leaf-tier** (*Phlyctænia ferrugalis* Hbn.)

A variety of garden and field crops including celery, beets, tobacco, and others are damaged by this insect. In addition it is injurious on plants grown under glass, especially roses, carnations, and chrysanthemums.

The larvæ usually bend a part of a leaf over on the rest, or fasten two leaves together with silk, feeding within. They are whitish caterpillars, with a green stripe down the middle of the back. The head is light brownish, and is marked with dark dots. When mature, the caterpillar is

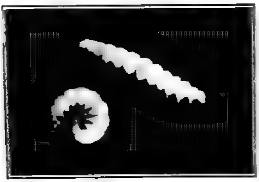

Fig. 228. — The Celery Leaf-tier. Larvæ. Original.

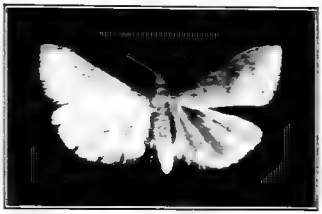

Fig. 229.—Adult of the Celery Leaf-tier. Original.

three fourths of an inch long. There are two or three generations outdoors, and an indefinite number in greenhouses.

Since the caterpillars feed for the most part concealed, poisons must be applied early in order to be at all effective. Paris green or arsenate of lead may be used. Hand picking is advisable wherever it can be practiced economically.

The Clover-hay Worm (*Hypsopygia costalis* Fab.)

Late in winter the lower layers of clover hay in stack or mow often are found matted together with silk. When the hay is turned over, active wriggling worms are dislodged. In spring the silk cocoons of the pupæ will be observed, here and there in the mass.

The adult, a small moth expanding less than an inch, emerges in

Fig. 230. — Work and larva of the Clover-hay Worm. Original.

June and July, and lays eggs on cured clover wherever it can be found. A second lot of moths are out in late summer.

If the hay is used up clean each year, and any refuse is destroyed, there will be practically no injury. If there is likelihood that all will not be used by the next July, salt down the first two feet of hay when putting it up, using two quarts of salt to the ton. Do not place new hay on top of remnants of last year's crop. The old hay should be removed and the mow thoroughly cleaned.

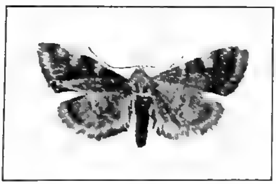

Fig. 231.—Adult of the Clover-hay Worm. Original.

Fig. 232. — Work of the Oblique Banded Leaf Roller. Original.

The Oblique Banded Leaf Roller (*Archips rosaceana* Harr.)

Roses and other plants in greenhouses and occasionally fruit tree foliage sometimes are badly injured by active, green or reddish caterpillars, three fourths of an inch long, which roll up the leaves, fasten them with silk, and feed within. The caterpillar has an indistinct darker stripe down the middle of the back, the head is dark brown or black, the segments of the body are rather distinct. The adult is a brownish, smooth moth, and emerges from a pupa formed within the rolled leaves.

FIG. 233. — Adult of the Oblique Banded Leaf Roller. Original.

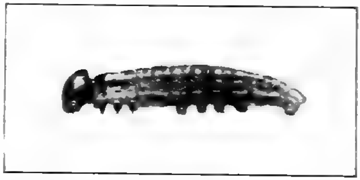

FIG. 234. — The Bean Leaf-roller. Original.

Hand picking is often the best means of control, though a prompt use of Paris green or arsenate of lead will check the pest, provided the application is made before most of the larvæ have retired into rolled-up leaves.

The Bean Leaf-roller (*Eudamus proteus* Linn.)

Rather odd-appearing worms, $1\frac{1}{4}$ inches long when mature, with narrow neck and prominent head, eat the leaves of beans and sometimes other legumes. The ground color of the larva is yellow, and its body is dotted with

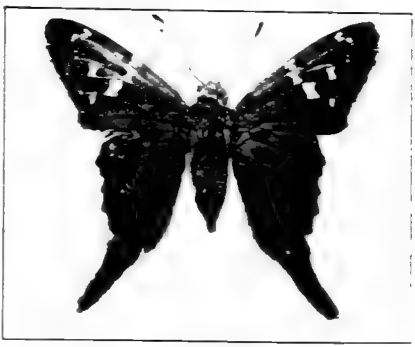

FIG. 235. — Adult of the Bean Leaf-roller. Original.

black. It occurs principally in the South, and there are several generations annually. The pest may easily be checked by applying arsenate of lead or Paris green, taking care not to use too heavy a dose, since beans are susceptible to burning.

The Spinach Leaf-miner (*Pegomya vicina* Lintn.)

Whitish mines are made in the leaves of beets and spinach by a maggot which burrows within the tissues. Several of these mines are seen often in a single leaf. The maggot is the larval stage of a gray, two-winged fly, which lays its eggs on the under side of the leaf. The pupal stage is passed in or on the ground. There are several generations annually.

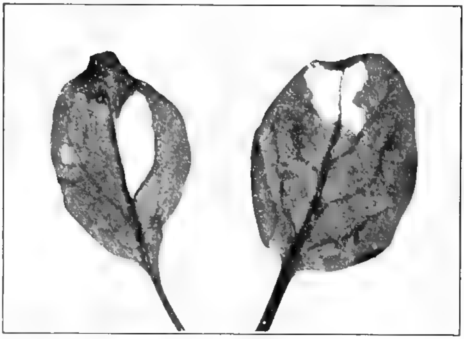

FIG. 236. — Work of the Spinach Leaf-miner. Original.

Since this pest lives also in lamb's-quarters, thorough destruction of this weed will help in control. Where practicable, infested leaves should be removed from the plants and destroyed. No successful sprays have been devised.

The Tobacco Leaf-miner (*Phthorimæa operculella* Zell.)

This pest is commonly known as the "split-worm." It is a very small larva, and injures the older leaves of growing tobacco by mining within the leaf tissues, causing small blotches. The larvæ move more or less from place to place, one worm making several mines. There are several generations in a single season. The native food plant is horse nettle.

Spraying or dusting with arsenate of lead or Paris green will kill many larvæ as they start their new mines. Horse nettles should

be destroyed. The worms may be killed in their mines by pressing the upper and lower leaf surfaces together.

The Squash-bug (*Anasa tristis* DeG.)

Few pests of the garden are more widely or more unfavorably known than the common squash-bug. As soon as squashes, cucumbers, or melons have made their first leaves, the overwintering adults appear and begin sucking the plant juices, causing the leaves to curl up, turn

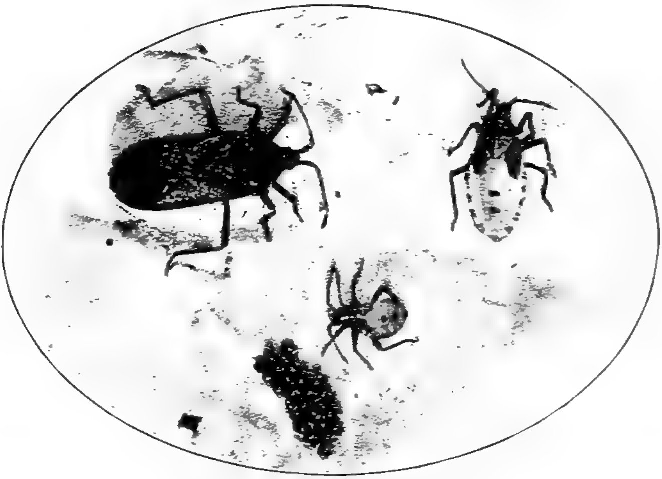

Fig. 237. — The Squash-bug. Eggs, nymphs, and adult. Original.

brown, and die. Before long one will find the first batches of eggs, and after a few days the young bugs begin to appear, to add to the damage.

Usually through summer all three stages, egg, young, and adult, are to be found on the vines at the same time. The adult is rusty brown to black, five eighths of an inch long, and provided with a strong sucking beak. Its head is small in proportion to the size of its body. The young, or nymphs, are grayish to black. They tend to cluster in colonies, hiding in a curled-up, dead leaf when not at work. The eggs

are laid in batches on the under side of a leaf, and are orange or red in color. They are easily seen.

The adults hibernate in old vines or other shelter. There is one brood annually in the North, but two or even three in the South.

The young may be killed by spraying with 10 per cent kerosene emulsion. Egg masses should be destroyed. The adults may be trapped under bits of board or stones, where they should be looked for frequently. Destroy the vines as soon as the crops are off, in order to kill the bugs not yet matured. No contact spray is known that will kill the adults without also seriously injuring the vines.

The Harlequin Cabbage-bug (*Murgantia histrionica* Hahn.)

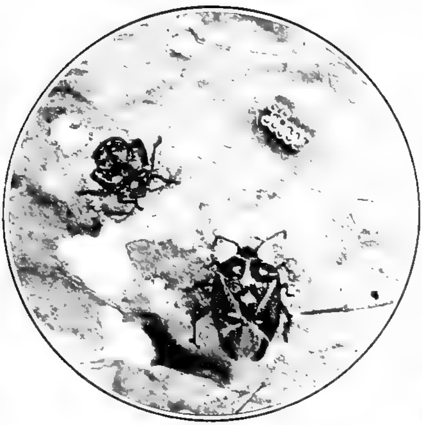

Fig. 238. — The Harlequin Cabbage-bug. Eggs, nymph, and adult. Original.

Cabbages, cauliflower, and related plants, in the South Atlantic states, are badly injured or destroyed by a small, gaudily colored bug, variously known as the "calico back," or "terrapin bug." The leaves of the plants attacked shrivel and turn brown, and often the plant is killed outright.

The adult bug is one fourth of an inch long, broad, shield shaped, and strikingly marked with red or yellow, and deep blue. The young, or nymphs, are similar in appearance. Close search of the leaves

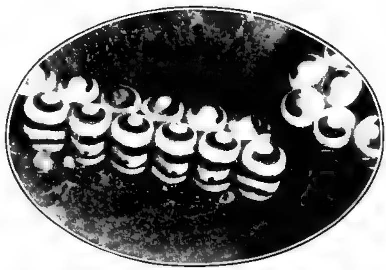

Fig. 239. — Eggs of the Harlequin Cabbage-bug. Enlarged. Original.

will reveal the peculiar-looking eggs, like white barrels with dark hoops.

The adults spend the cold weather in rubbish or other shelter, and become active very early in the spring, feeding first on wild mustard and other weeds of the same family. There are several generations in the South. In the fall the bugs feed until driven in by cold weather.

The most important control measure is a thorough cleaning up early in the fall, as soon as the crops are harvested, combined with an early planting of trap crops in the spring, on which the bugs will congregate and where they may be destroyed by spraying with 25 per cent kerosene emulsion or with pure kerosene. Kale or mustard are good traps. After the bugs are on cabbages they cannot be killed by spraying without at the same time injuring the plants.

The Tarnished Plant-bug (*Lygus pratensis* Linn.)

Truck crops of all kinds are injured by a small, brownish, sucking bug. Both in its earlier stages and as a winged adult, it sucks the juices of the leaves or tender stems. The mature bug is about one fifth of an inch long, and somewhat obscurely marked with dull yellow and brown.

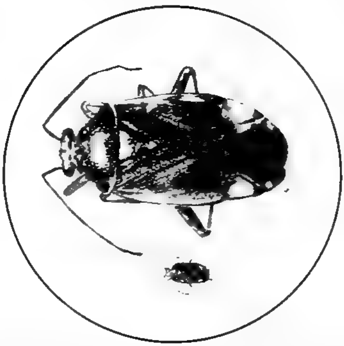

FIG. 240. — The Tarnished Plant-bug. Enlarged and natural size. Original.

The young nymphs may be killed with a contact insecticide such as 7 per cent kerosene emulsion or tobacco extract. The winged adults are too active to make this treatment effective. Thorough cleaning up of all rubbish and crop remnants in the fall is the only other means of control.

The False Chinch-bug (*Nysius ericæ* Sch. (*angustatus* Uhl.)) has similar habits. There are various other species that occasionally are troublesome. Control measures are the same.

The Chinch-bug (*Blissus leucopterus* Say)

One of the most destructive insects in the history of American farming is the species of sucking bug occasionally attacking corn and wheat in countless millions, and known as the chinch-bug. When it is numerous, fields are blasted as if by fire.

The bug that causes this damage is quite small, one fifth of an inch long or less, dark or black in color, and with thin, white wings folded across the body when at rest. In the East another form is found with wings much shorter. The immature stages are often seen with the adults, and differ little in shape, but are wingless, smaller, and when young are bright red.

The adults overwinter in clumps of grass, fallen leaves, weeds, and rubbish accumulating along fence rows, strips of woodland, and especially in corn shocks left in the fields. They come from these places in spring, and lay eggs in grain fields or on suitable weeds. The young appear in May and June. These mature, and there is a second lot of young in August or early September.

FIG. 241. — Chinch-bugs on corn plant. Original.

Where small grains are infested, the swarms of bugs are driven from these at harvest and travel in armies to corn, which they literally overwhelm. When large numbers of adults have hibernated, the most striking injury may be

that caused by adults and young on the grains to which the adults have migrated in the spring. This is especially evident where corn shocks have been left standing in fields seeded to small grain.

Meaures of control are various, and must be thorough and timely. The most important measure is destruction of all hibernating places where the bugs are accustomed to spend the winter.

Clumps of grass should be raked up and burned; fence corners cleaned out; all places that harbor bugs looked after. If plowing is depended on to destroy hibernating bugs, it must be done with great thoroughness, else the bugs will succeed in reaching the surface of the ground.

FIG. 242. — The Chinch-bug. Enlarged and natural size. Original.

Invasions of the bugs from newly harvested fields can be prevented by suitable barriers, among which the following is known by experience to be practicable and effective: A strip of ground along the side from which the invasion threatens is smoothed and compacted by dragging over it a heavy plank. Along the center of this path a narrow line of coal tar or road oil is poured. The line of oil need be only half or three quarters of an inch wide. At intervals of three or four rods post holes are dug, the edge of the hole nearest the field to be protected just intercepting the line of oil. The invading bugs, when they reach this line, travel along it until they come to the angle of the oil line and the hole, when they are crowded into the hole and are unable to get out. They can then be killed easily by sprinkling with kerosene or kerosene emulsion, or by crushing with a pole. In dusty weather the oil line will need renewal every day or so, while the invasion threatens.

If a field of wheat is seen to be beyond reasonable hope, it is best to plow it under at once, harrow thoroughly, and plant to potatoes, alfalfa, soy beans, garden truck, or whatever is seasonable.

In meadows where severe attack is noted the wisest measure is to cut and then burn over, although this probably will kill the grass roots.

In moist weather chinch-bugs are killed in large numbers by a fungous disease. Attempts have been made to propagate this artificially, but the measure cannot be depended on with sufficient certainty in times of severe attack.

The Tobacco Suck-fly (*Dicyphus minimus* Uhl.)

In Florida a black, sucking bug, one eighth of an inch long, with long greenish legs, attacks the leaves of tobacco and by its punctures spots the leaf, making it wilt, turn brown, and crack. The younger stages feed in similar fashion on the under surface of the leaf. There are several generations annually. Spraying with tobacco extract will kill the immature forms and check the pest.

The Beet Leafhopper (*Eutettix tenella* Baker)

A very small, active insect, one of the "leafhoppers," swarms on the foliage of sugar beets in countless myriads. The leaves of plants attacked usually exhibit a characteristic appearance, commonly known as "curly leaf." The edges are rolled in, the leaf surface is wrinkled, and growth is stunted. As a consequence the beet puts out many fibrous roots, does not reach normal size, and its sugar content is low.

FIG. 243. — Beet leaves curled by the Beet Leafhopper. Original.

The adult is very small, whitish or pale green, winged, and is provided with strong hind legs, en-

abling it to jump quickly and take wing readily. The younger stages are similar, but are smaller and wingless. Usually the hoppers appear in the beet field suddenly, having fed first on some other plant, probably species of weeds. In hot, dry fields conditions are especially favorable to the pest and unfavorable to the beets, while in fields where the reverse conditions prevail the beets are able to withstand attack.

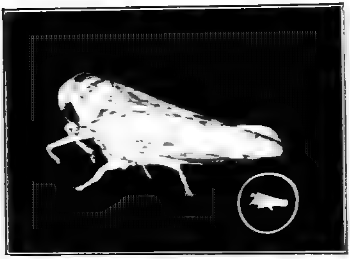
FIG. 244. — The Beet Leafhopper. Enlarged and natural size. Original.

Infested fields may be sprayed with a contact insecticide, making the first application just as the young nymphs are found in numbers, and repeating. Kerosene emulsion may be used, diluting the stock solution with 8 parts of water. It is very difficult, however, to hit all the insects with the spray. A drag may be used to turn the leaves over, so as to help to make the application more thorough.

Frames coated with tar dragged through the fields at the first appearance of the adults will catch many, and will help to check injury.

The Spring Grain-aphis, or "**Green Bug**" (*Toxoptera graminum* Rond.)

Occasionally, in recent years, oats, wheat, barley, and sometimes corn have been damaged to the extent of millions of dollars by this tiny louse. It occurs in both winged and wingless forms. The latter is about one twentieth of an inch long, yellowish green, with a faint dark line down the middle of its back. Its eyes are quite black. The winged form is a little larger, has a dark thorax, but otherwise is of the same general appearance.

Attack comes on suddenly in the spring. Countless billions of the lice appear on young grain, sucking the juice of the leaves, stunting the growing plants or killing them outright. Reproduction goes on rapidly. When the fields in a section attacked are destroyed, or the plants have

grown and thus have acquired tougher leaves, the lice develop a winged generation, leave the section where at work, and appear as suddenly in other regions farther north, where conditions are favorable to further multiplication.

Late in summer, as the grain fields mature, the lice leave them and take up their residence on grasses, such as common bluegrass or on corn. In the fall, when winter grain has sprouted, many move back to the new feeding ground. With the coming of cold weather, eggs are laid among grain plants. In the more Southern states there are living

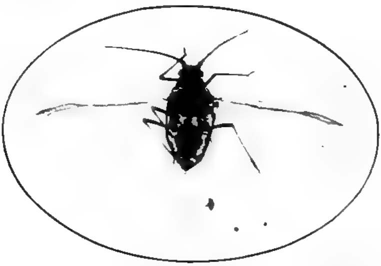

FIG. 245. — The Spring Grain-aphis. Winged adult. Enlarged and natural size. Original.

FIG. 246. — The Spring Grain-aphis. Wingless form. Enlarged and natural size. Original.

females in existence all winter. The insect is able to breed at unusually low temperatures.

Oats and wheat are the favorite food plants, but the list includes rye, barley, corn, and several species of wild grasses, especially orchard grass.

Normally this insect is held in check by its natural enemies, especially by a four-winged parasite which attacks the lice, laying its eggs within their bodies. Severe attacks follow warm winters combined with cold springs — a condition unfavorable to the parasite, but favorable to the aphis.

Direct control is not feasible. Cleaning up volunteer oats and other food plants in the fall will greatly reduce the numbers the following spring. Attempts have been made artificially to introduce the parasite, but without entire success.

The European Grain Aphis (*Siphocoryne avenæ* Fab.)

In summer the leaves, stems, and heads of small grains sometimes are literally covered with this species of plant lice. They are rather pale green in color, marked with short bands of darker green on the back, and for the most part are wingless. Usually their increase is quickly followed by a similar increase in parasites, so that serious injury is averted, but occasionally they seriously damage young wheat in the fall.

The lice come to the grain fields in the spring from fruit trees, where they have passed the winter in an egg stage, and have already gone through one or two generations on the fruit buds and foliage. They return to the trees in the latter part of summer or the fall.

No direct measures of control on grain are known.

The Corn Leaf-aphis (*Aphis maidis* Fitch)

In midsummer, corn, or more especially sorghum and broom corn, becomes infested with bluish green lice which work on the younger leaves, and on the tassel. On broom corn their punctures often are followed by a red discoloration due to a bacterial disease. The wingless female is usually seen. It has black legs, antennæ, and honey tubes, and a row of black dots down either side of the back.

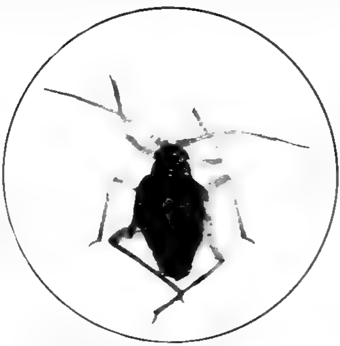

Fig. 247.—The Green Peach Aphis. Enlarged. Original.

Winged generations are developed as the corn matures, but the alternate host plants, if any, are unknown. No remedial measures have been devised.

The Green Peach Aphis, or Spinach Aphis (*Myzus persicæ* Sulz.)

This plant louse often is known as the spinach aphis, or "green fly." It is the same species as the louse found on the foliage of peach trees early in the season,

and known there as the "green peach aphis." The lice migrate in early summer to various truck crops, especially spinach, cabbage, lettuce, and celery. They are light green or yellowish in color, with darker markings on the abdomen. The head, antennæ, and honey tubes are black. This species is never covered with white powdery secretion, like the cabbage aphis. It is controlled by spraying with a contact insecticide, preferably tobacco extract or 5 per cent kerosene emulsion. In greenhouses this species is found throughout the year, and is a troublesome pest.

The Melon Aphis, or **Cotton Aphis** (*Aphis gossypii* Glov.)

Melons, cucumbers, cotton, strawberries, and many other plants are subject to infestation by this species of plant louse. It usually is seen in the wingless form, and works for the most part on the under surface of the leaf, which is badly curled by its attack. Tender growing shoots are a favorite feeding place.

Fig. 248. — Work of the Melon Aphis. Original.

The wingless louse is dark green, varying to yellow. Its legs are light yellow, and its honey tubes are black, long, and tapering. Its length is one fifteenth of an inch. The young stages are similar, but are smaller and wingless. Winged individuals are developed whenever the lice are compelled, through lack of food or removal of a crop, to seek new feeding ground. Consequently attack may come on suddenly and unexpectedly. The full life round is not known, and probably the species passes one

or more generations on some alternate host plant, and survives there through the winter.

When found on garden crops, the lice may be killed by spraying with tobacco extract or 5 per cent kerosene emulsion. Fumigation with carbon bisulphide will destroy them, using an inverted tub as a fumigating chamber. The dose should be at the rate of one tablespoonful of carbon bisulphide to a 20 gallon tub. Aphis punk may be substituted for the carbon bisulphide and a light frame of oiled muslin may take the place of the tub.

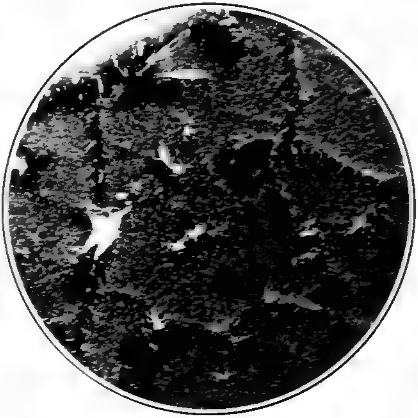

Fig. 249.—Wingless and winged adults of the Melon Aphis on Leaf. Enlarged. Original.

Where cotton is infested, direct control is impracticable. In this case adopt rigorous clean culture so that weeds may be kept down in and around the field.

The Pea Aphis (*Macrosiphum pisi* Kalt.)

In seasons of abnormally dry spring weather a large green plant louse becomes abundant on peas. The adult lice are one eighth of an inch long, pea-green in color, with prominent dark red eyes, and long legs. They feed on the leaves and cluster on the terminal shoots. Usually they reach their greatest abundance in midsummer, and disappear in August.

The lice come to the pea vines from clover fields, where they have spent the winter as tiny, black eggs. The first generations live on the clover. Winged individuals appear as the season advances, and migrate to peas. In August they return to clover.

Contact sprays may be used in direct control on peas. Tobacco extract is effective, or 5 per cent kerosene emulsion may be employed.

If peas are planted far enough apart in rows and the ground is dry, the lice may be brushed from the vines and killed by following with

FIG. 250. — The Pea Aphis. Adults at work on vine. Original.

a cultivator between the rows. If the ground is wet, the lice may be brushed into a long, shallow pan. A little water should be poured into the pan and covered with a film of coal oil.

The Bean Aphis (*Aphis rumicis* Linn.)

The tender shoots of beans sometimes are covered with thickly clustered plant lice. The same species is found commonly on pigweed, dock, and other weeds. The aphis is one tenth of an inch long, black, often with a few whitish dots on each side; the antennæ are whitish in their central segments.

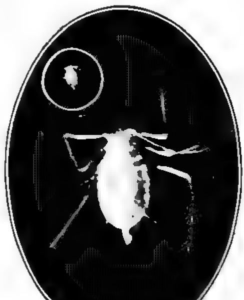

FIG. 251. — The Pea Aphis. Adult enlarged and natural size. Original.

Winter is passed in an egg stage on the twigs of wahoo or of snowball. The lice first migrate to weeds and then to beans. In late summer, they return to the shrubs named.

On beans they may be killed by spraying with tobacco extract, or with 5 per cent kerosene emulsion.

The Cabbage Aphis (*Aphis brassicæ* Linn.)

Cabbage, cauliflower, and related plants are subject to infestation by a soft-bodied plant louse, which collects in masses on the surface of the leaves. The lice are green, but are covered with a whitish, powdery secretion.

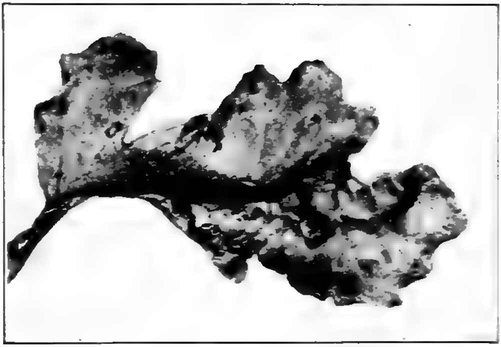

FIG. 252. — Work of the Cabbage Aphis. Original.

Winter is passed as eggs on old cabbage stumps or heads in the field. There may be a dozen or more generations in a summer.

Spray thoroughly with tobacco extract to which soap has been added, or with 5 per cent kerosene emulsion, or with soap solution, 1 pound in 3 gallons of water. Dip infested seedlings in the same solution before setting out. Dispose of crop remnants. Judicious rotation will help in delaying attack. Wild mustard and shepherds-purse should not be allowed to grow near cabbage.

The Potato Plant-louse (*Macrosiphum solanifolii* Ashm.)

In occasional seasons potato vines are seriously checked in the latter part of summer by myriads of green, soft-bodied plant lice, which suck the juices of leaf and stem. Spraying the fields with contact insecticides, either tobacco extract or 5 per cent kerosene emulsion, will kill the lice. Since the pest survives the winter on alternate host plants, especially shepherds-purse, clean culture and burning over waste places

is recommended. The potato vines themselves, also, should be burned.

The Hop-aphis (*Phorodon humuli* Schr.)

Hops are subject to infestation by a green, soft-bodied louse, one eighteenth to one twelfth of an inch in length. The male plants in hopyards always are infested first, and from these the lice spread two or three weeks later to the female or fruiting plants. Their attack causes the leaves to turn yellow, and seriously reduces the yield.

Recent studies show that the winter may be passed in an egg stage somewhere near or on the hop-vines, although it is known that the same species winters also on plum trees. There are many generations in the course of a summer.

Thorough spraying with a contact insecticide, such as tobacco extract or 5 per cent kerosene emulsion, will kill the aphids. Remedial treatments should be begun while the lice are still isolated on the male plants, before spread has started.

The Greenhouse Thrips (*Heliothrips hæmorrhoidalis* Bouché)

The foliage of plants in greenhouses sometimes is injured by a very small, sucking insect properly known as a thrips. Evidence of the work is seen first in numerous whitish spots, where the juices of the leaf have been sucked out. These spots show in the beginning more plainly on the lower surface. As attack goes on, the spots spread, forming blotches, dead areas appear around the edges of the leaf, the foliage wilts, and finally drops off. The surface of the leaf is covered with small drops of reddish fluid, which frequently turns black.

The adult insect is one fifteenth of an inch in length, dark bodied, and though it has wings is not much disposed to fly. The young are lighter colored, and have no wings. They suck the leaf juices just as do the adults. Three or four weeks are required for a generation.

Usually this pest is controlled successfully by fumigation with tobacco.

The Onion Thrips (*Thrips tabaci* Lind.)

A great variety of truck crops and some flowering plants under glass are subject to injury by this minute form of insect life. The juices are sucked from the leaves, causing numerous tiny white spots. The insect itself is so small as almost to escape notice. It is yellowish, slender, and one twenty-fifth of an inch long. Eggs are laid within the leaf tissue. Several generations may be developed in a season.

Fig. 253.—White spots on onion leaf caused by the Onion Thrips. Enlarged to twice natural size. Original.

Crop remnants and neighboring weeds should be burned in the fall. Attack may be checked by spraying with tobacco extract, being careful to get the material into the axils of leaves, since such places are favored by the pest. The insects are more active on the outer parts of the plant in the early morning, and thus are more easily reached at that time.

The Tobacco Thrips (*Euthrips nicotianæ* Hinds)

The work of this minute insect may be recognized by a whitening of the leaves, especially along the veins. The adult winters in tobacco fields, and breeds rapidly in the warmer months. Before tobacco plants are up and after they are gathered it lives on weeds, or often on oats.

Spray with kerosene emulsion, diluting the stock emulsion with 10 parts of water.

The Grass Thrips (*Anaphothrips striata* Osborn)

Usually the work of this insect is observed rather than the pest itself. Various grasses, including oats, turn white, the appearance being known as "silver top." More closely examined, the leaves will be found covered with white dots where the juices have been sucked out,

and further observation will disclose the minute, slender insects that are doing the mischief. They are one twenty-fifth of an inch long, the larger winged individuals brownish in color and the smaller wingless forms somewhat pinkish.

Winter is passed in débris at the base of the plants. There are several generations in the course of a summer.

Remedies are rotation of crops, or burning over infested fields in winter.

The Greenhouse White-fly (*Aleurodes vaporariorum* Westw.)

Wherever plants are grown under glass this troublesome pest is sure to put in its appearance, and injure the plants by sucking their juices.

FIG. 254. — Larvæ and adult of the Greenhouse White-fly. Enlarged. Original.

The adults have four wings, covered with a whitish powder, and are active creatures, flying readily. They are about three fiftieths of an inch in length. The young are flattened, oval in shape, and have sucking mouth parts, like the adults.

The insect is nearly always found on the under side of the leaves, and prefers the younger foliage at the upper part of the plant. The leaves attacked lose their vitality, and if the insect is not checked, the

plants will die. Cucumbers and tomatoes usually are badly infested, but almost any vegetables or flowering plants grown in greenhouses may be attacked.

The most effective remedy is fumigation with hydrocyanic acid gas. Some benefit will be derived from spraying with whale-oil soap, $1\frac{1}{2}$ ounces to 1 gallon of water.

Mealy Bugs

Slow-moving, oval, soft-bodied bugs, one tenth to one sixth of an inch long, the body covered with a whitish, powdery secretion, infest various plants grown under glass. In the South they are a nuisance

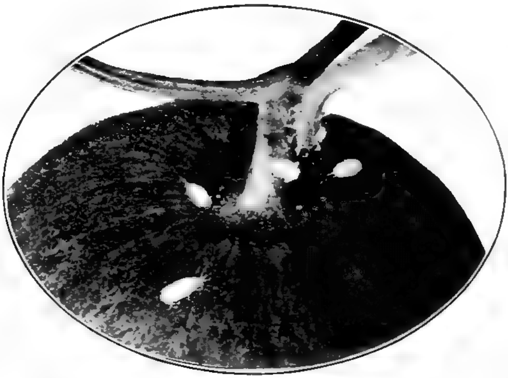

FIG. 255. — Mealy Bugs on melon. Original.

on citrus fruits. The Citrus Mealy Bug, *Pseudococcus citri* Risso, and a closely related form, *Pseudococcus longispinus* Targ., are common species.

The young are small, red, and fairly active at first. The adult males are winged.

Contact insecticides, especially such as contain soap or oil, are effective remedies. They should be applied with considerable force in order to penetrate the waxy powder with which the bodies of the insects are coated.

The Red Spider (*Tetranychus bimaculatus* Harv.)

In greenhouses, throughout the year, many plants are subject to attack by an exceedingly small mite, commonly known as the "red spider." Very fine webs are spun on the under surfaces of leaves or over flower heads, and beneath these the mites work, sucking the juices of the leaves, giving them a sickly yellow or brown appearance, and finally killing the plants, unless checked.

In the Southern states cotton is injured by this species, the leaves turning brown and falling off.

Vegetables grown outdoors, especially beans, cucumbers, and melons, often are infested, particularly in the Southern states. Rarely, shade trees in the South are injured.

The mite is reddish or greenish in color, one fiftieth of an inch long, has four pairs of legs, and its body is marked with two darker spots.

Fig. 256.—Foliage injured and webbed by the Red Spider; and adult Red Spider, greatly enlarged. Original.

In greenhouses, fumigation is not effective. The mites may be controlled by frequent spraying with clear water or with soap solution. On such plants as are not injured by sulphur an effective treatment is a spraying with water 1 gallon, flowers of sulphur 1 ounce.

On cotton or truck crops the last-mentioned spray is effective. Or the plants may be dusted with a mixture of sulphur and air-slaked

lime. Around cotton fields weeds should be kept down, and in the fall all dead, infested cotton plants should be burned.

The Clover Mite (*Bryobia pratensis* Garm.)

Both the leaves of clover and the foliage of various fruit trees are attacked by a small, eight-legged mite, which sucks their juices, causing much injury when abundant. It is a tiny red creature three hundredths of an inch in length.

On clover no direct remedial measures seem feasible. The mite passes the winter as a rule in an egg stage on the bark of neighboring fruit trees. It may be killed there by spraying in winter with lime-sulphur solution.

Fig. 257.—The Clover Mite. Enlarged to fifteen times natural size. Original.

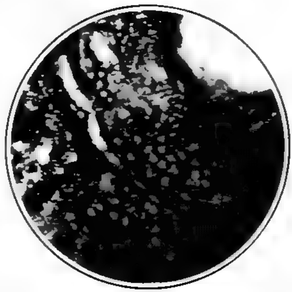

Fig. 258.—Eggs of the Clover Mite on bark. Enlarged to ten times natural size. Original.

The Cotton Boll Weevil (*Anthonomus grandis* Boh.)

No pest of recent years has wrought greater damage than this invader from Mexico. It is now distributed throughout the greater part of the cotton-growing regions.

Both the squares and the bolls are attacked, their substance eaten out, and their contents so damaged that they die or fail to produce fiber. The injury is wrought both by the adults in their feeding and egg-laying punctures, and by the grubs which hatch from the eggs laid within the bolls or squares.

The adult boll weevil is a small snout beetle, one fourth of an inch long. It is brownish in color through most of its existence, but lighter when newly emerged and darker after it has been out for two or three weeks. The grub, found only within the squares or bolls, is whitish, heavy bodied, and has a dark head. It has no feet.

In the early spring the adult beetles appear in the cotton fields from their winter hiding places. Usually there are but few of them at this time. When the squares begin to form, eggs are laid within them, and as the grub develops the square usually falls to the ground. A pupal stage is passed within the square, and soon a second generation of adults is out. Eggs are now laid in the squares as before. There are four or five generations in the course of the season. When the squares are no longer available, eggs are laid in the bolls in similar fashion.

FIG. 259. — Work of the Cotton Boll Weevil. Original.

Hibernation of the adult weevils does not begin until late in the season, long after the regular crop of cotton is picked. When the first frosts come, the adults seek shelter in which to spend the winter, while the immature stages die. At this time the adults fly to considerable distances, seeking places to hibernate.

FIG. 260. — Larva of the Cotton Boll Weevil, enlarged and natural size. Original.

FIG. 261. — Adult Cotton Boll Weevil. Enlarged and natural size. Original.

The most important means of control is a thorough cleaning up of the cotton fields as soon as the crop is gathered, together with destruction of all stalks, dead bolls, and crop remnants. At this time the existing adult beetles are not yet ready to hibernate, and there are many grubs and pupæ in the field that would later become beetles, coming out at the normal time of hibernation. These immature stages are thus destroyed, and the adults, left with no cotton plants to feed on, are for the most part starved, or are unable to get to suitable places to spend the winter. In destroying the stalks it is best to plow them out, leaving a row now and then, at once raking the loose plants to the standing row and burning the entire lot.

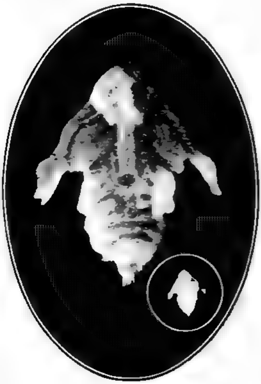

Fig. 262. — Pupa of the Cotton Boll Weevil. Enlarged and natural size. Original.

Early in the season, when it is seen that squares are being badly punctured, and are dropping off in large numbers, a chain drag may be drawn between the rows so as to draw the squares into the middles, where they will get the full force of the sun. Most of the grubs within will be killed by the heat.

It is possible to poison a large percentage of the adult weevils by applying powdered arsenate of lead to the squares with a blower or powder gun, making the first application as soon as squares begin to form, and repeating as necessary.

Any practice that will help to get the cotton planted and matured early will greatly help to avoid serious injury, because the cotton will then be well along before the weevils have become numerous. Thus, winter plowing, early spring planting, and the use of early maturing varieties, together with frequent cultivation in the growing season, are advisable. By this means the plants are stimulated to quick, vigorous growth, and escape serious attack at the period when they are more susceptible to injury.

The Cowpea Curculio (*Chalcodermus æneus* Boh.)

The pods of cowpeas are punctured, and early in the spring young cotton plants are injured, by the feeding of this beetle. The immature stage or grub lives within the growing "peas," and ruins them for seed. The adult beetle is one fourth of an inch long, bronze black, its thorax and wing covers deeply pitted. When working on cotton, the beetles puncture the tender stems.

The insect hibernates as an adult. Eggs are laid in cowpeas as soon as the pods are large enough. The larva enters the ground to pupate.

No direct control measures are known. If cowpeas are badly infested, it is unwise to follow with cotton in the same field.

The Corn Ear-worm (*Heliothis obsoleta* Fab.)

Synonyms: **The Cotton Boll-worm; the Tomato Fruit-worm; the Tobacco False Budworm**

Widespread injury to valuable garden and field crops is due to the ravages of this insect.

The full-grown worm is variable in markings, but usually is dull greenish or brownish in color, with indistinct stripes or spots, and is

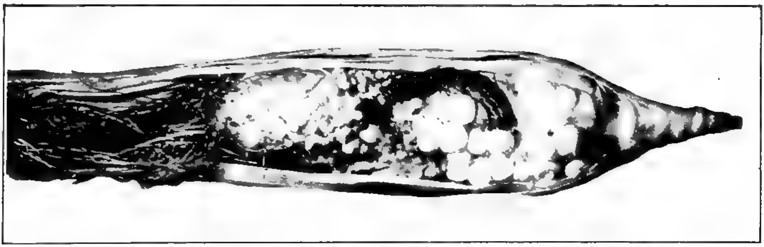

FIG. 263. — Larva and work of the Corn Ear-worm. Reduced to one half natural size. Original.

about $1\frac{1}{2}$ inches long. It is naked, and the skin looks somewhat greasy, like that of cutworms.

On corn the worms feed in the young kernels and eat the tender

silk inclosed within the husk. They are especially destructive to sweet corn.

On tomatoes they bore into the fruit and eat more or less of the pulp within.

Cotton is attacked at the time that the corn in southern fields is maturing, and therefore is no longer suitable for food. The worms eat into the bolls.

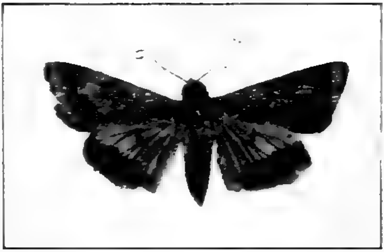

FIG. 264.—Adult of the Corn Ear-worm. Original.

Tobacco is subject to injury at the same season, the larvæ eating into the buds and stalks, though in Florida the plants are attacked also early in the season and the leaves mutilated before they have unfolded.

The adult is a yellowish or brownish moth, expanding a little more than $1\frac{1}{2}$ inches. There are two broods in the North, and from four to six in the South. The eggs of the first generation are laid on any available food plant, depending on the section of country. Succeeding broods do the greater part of the injury. Winter is passed as a pupa in the soil, in a peculiar burrow constructed by the larva, which descends several inches, turns, and makes a gallery nearly to the surface of the ground for the use of the moth in emerging, and then retires to the bottom of the gallery to transform.

One of the best means of control is fall plowing and cultivation, so as to break up the exit galleries in the soil.

Prevention of attack by the later broods often is difficult. Early planted corn is more likely to escape injury. The same is true of cotton. On cotton, arsenical poisons are used with good results, usually applied dry. Strips of late corn planted among cotton after the latter is under way will come into silk at the right time to divert attack from the cotton. Cowpeas may be used in the same way.

On tobacco buds an effective remedy consists in poisoning the worms with a mixture of corn meal and dry arsenate of lead, using 1

teaspoonful of the arsenate of lead to a quart of meal. Apply the mixture dry, sprinkling it on or into the buds.

The same remedy is available when the worms are troublesome, boring into tomatoes.

The Tobacco Budworm (*Chloridea virescens* Fab.)

Injury by this species becomes noticeable late in the season, the larvæ boring into the rolled-up leaves or buds, and later into seed pods. In appearance the caterpillar resembles the boll-worm, but is smaller, and its stripes are narrower and more distinct. The life round is similar to that of the boll-worm, and the means of control are the same.

Cutworms attacking Cotton Bolls

Certain species of cutworms frequently climb the stalks of cotton and bore into the bolls. The one most commonly observed, *Prodenia ornithogalli* Guen., may be recognized by two rows of triangular black spots down its back, edged with very narrow light stripes. One or more earlier generations are passed on weeds.

Application of arsenicals will help to check the pest. Use the same remedies recommended for the boll-worm or "corn ear-worm" attacking cotton.

The Cotton Square-borer (*Uranotes melinus* Hbn.)

Cotton squares are bored into and their inner substance eaten by a flat, oval worm, clear green in color, its head drawn in beneath the front part of its body.

Cowpeas, and certain weeds, are favorite food plants, as well as cotton. Eggs are laid on the leaves, and the larvæ feed exposed for a few days before boring into the squares. The adult is a deep red butterfly, with shining red spots at the lower edge of the hind wings.

Dusting or spraying with arsenate of lead or Paris green will kill the young worms if the application is made early, before they bore into the squares.

The Wheat-head Army-worm (*Meliana albilinea* Hbn.)

Naked, dark brown or green, striped caterpillars eat into the heads of wheat, or other small grains, and in the same way are destructive

Fig. 265.—The Wheat-head Army-worm. Larva and adult, natural size, and work in wheat head, enlarged. Original.

on the heads of timothy. Their work is confined largely to the kernels, the chaff falling to the ground.

They are at work in June and July, and a second brood appears in the later summer months. The adult is a brownish yellow moth. At the end of summer the full-grown caterpillars of the second brood enter the ground, where the winter is passed.

Early fall pasturing will starve out the second brood of caterpillars. With this should be combined the destruction of wild grasses, for the worms will feed on these in lack of their favorite food. Stock may be removed from the pastures by the middle of September if desired. Early fall plowing, where feasible, will accomplish somewhat the same result.

The Pickle Worm (*Diaphania nitidalis* Cramer)

In the Southern states ripening melons, squashes, and cucumbers are rendered worthless by a whitish or greenish worm, half an inch

FIG. 266. — The Pickle Worm. Original.

to an inch long, which bores holes into the fruit, feeding both on the rind and inside. Blossoms, leaves, and stems, also, are injured, but the damage to the fruit is the most serious.

The adult is a handsome moth, brownish in color, with large, clear

areas in its wings, and expanding one to one and a quarter inches. At the end of the abdomen is a brush of brown hairs. There are four generations in a season. The winter is passed as a pupa in dried and folded leaves on the ground. Usually the moths are not abundant until July.

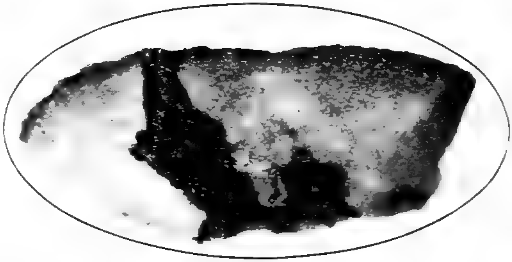

FIG. 267.—Section through melon showing work of the Melon Caterpillar. Original.

The most effective means of control is the planting of early squashes, as trap crops, among the melons. The insect will choose the squashes for its egg laying, and if the melons are of an early variety, they will practically escape injury. Destruction of rubbish and fall plowing will help.

The Melon Caterpillar (*Diaphania hyalinata* Linn.)

Damage by the melon worm is similar to that done by the pickle worm. Squashes, melons, cucumbers, and related plants are subject to

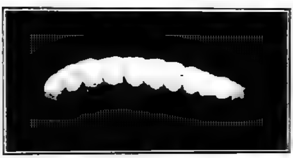

FIG. 268.—The Melon Caterpillar. Original.

FIG. 269.—Adult of the Melon Caterpillar. Original.

attack, the worms first eating the foliage and then boring into the fruit. The full-grown worm is $\frac{3}{4}$ to $1\frac{1}{2}$ inches long, yellowish in color, and marked with two narrow light stripes down its back. The adult has white wings, broadly bordered with dark brown. The winter is passed as a pupa in folded leaves on the ground. There are three to four generations annually. The species is most injurious in the Gulf states.

Since the worms devour the foliage before feeding in the fruit, the best remedy is to apply arsenate of lead or Paris green to the vines. Crop remnants should be cleaned up, and fall plowing is advisable. Early squashes may be used as traps, to divert attack from melons.

The Pea-moth (*Cydia* (*Semasia*) *nigricana* Steph.)

In northern sections growing peas are subject to infestation by a cylindrical, light yellow larva, half an inch long when full grown, which works in the young seed within the growing pod. Infested pods ripen early, crack open, and the worm then emerges and goes into the ground to transform. The eggs are laid on the pods about the close of the blossoming season. Arsenate of lead or Paris green applied at this time and again in ten days will check the pest. Early peas are not usually much infested, and the same is true of very late varieties.

The Clover Seed-caterpillar (*Laspeyresia* (*Enarmonia*) *interstinctana* Clem.)

Tiny, whitish worms, a third of an inch long when full grown, work in the growing heads of clover, eating the florets or the soft, forming seeds. In their work they hollow out a cavity in the head, which fails to bloom or often blooms on one side only. If a head is torn open, the caterpillar will be found inside.

The adult moth appears at the time of the first blooming of clover. Succeeding generations are on the wing at the time of the second blooming, and again in late summer. Hibernation takes place as pupæ in silk cocoons on the ground, or sometimes as adults.

In control, make the first cutting of hay early in June, while the caterpillars are still in the heads, and store this hay as soon as possible. Pasture clover fields in the fall. Plant new fields remote from old ones. Plow up old fields in the fall or early spring, and in the spring harrow and roll.

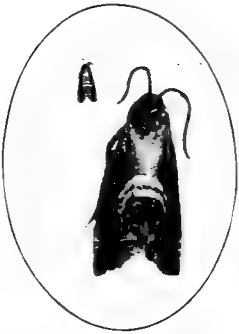

Fig. 270. — The Clover Seed-caterpillar. Adult, enlarged and natural size. Original.

Fig. 271. — Work of the Wheat Midge. Enlarged to three times natural size. Original.

The Wheat Midge (*Itonida* (*Contarinia*) *tritici* Kby.)

The "red weevil" is another common name of this insect. When it is present in large numbers in the heads of wheat, oats, or rye, it gives them a pinkish tinge. The damage is done by a tiny pink maggot, which feeds on the forming kernel, within the protection of the glumes. As a result of its work the ripe kernel is shrunken, and the yield, especially of wheat, seriously reduced.

When mature, the maggot falls to the ground, spins a delicate cocoon, and remains there until the next spring, when the tiny, gnatlike adult comes out, ready to lay eggs again on the forming heads.

Fall plowing is an effective remedy. Instead of this the stubble may be burned over. If clover is growing in the stubble, burn in winter when the ground is frozen, so that the roots may not be injured.

The Sorghum Midge (*Contarinia sorghicola* Coq.)

Heads of sorghum are attacked by the larva of a minute two-winged insect or "midge," preventing the formation of seed. If infested heads are examined, the seeds will be found shriveled, while beside them may be seen a tiny grub. Profitable crops of seed cannot be secured where the midge is abundant.

The first generations of the midge are passed in other plants that mature heads earlier, notably Johnson grass. By the time the sorghum is sufficiently mature the midges are numerous. Eggs are laid within the developing seeds.

Remedial measures include destruction of Johnson grass, and clean harvesting in the fall.

The Clover Flower-midge (*Dasyneura leguminicola* Lint.)

The presence of the clover flower-midge is recognized by the fact that the florets of clover bloom fail to develop normally, become shrunken, and the whole head lacks color.

The adult insect is a minute, gnatlike creature with long legs and dusky wings. Eggs are laid in the clover head, and the larva feeds in the ovaries, preventing the normal expansion of the floret and the development of seed. A pupal stage is passed in the ground, followed by a second brood at the time of the second blooming of clover. Winter is passed in the soil.

Fig. 272. — Clover head showing irregular blooming caused by the Clover Flower-midge. Original.

In fields containing mostly clover and little timothy it is

FIG. 273.— The Clover Flower-midge. Florets showing arrested development. Original.

feasible to cut for hay early, before the larvæ have done much damage or completed their growth. The second crop will then be free of attack.

Where timothy is combined with clover, the insect is controlled by clipping back the growth in May, thus retarding the blooming of clover past the danger point, since the heads will not be at the blooming period when the midges are flying. Here again the second blooming will be exempt.

The Clover Seed Chalcid Fly (*Bruchophagus funebris* How.)

The larva or grub of this tiny insect lives in the ripening seeds of clover or alfalfa. Its presence is seldom suspected, and the only evidence may be the shortage of the seed and the large quantity of empty hulls blown out with the chaff.

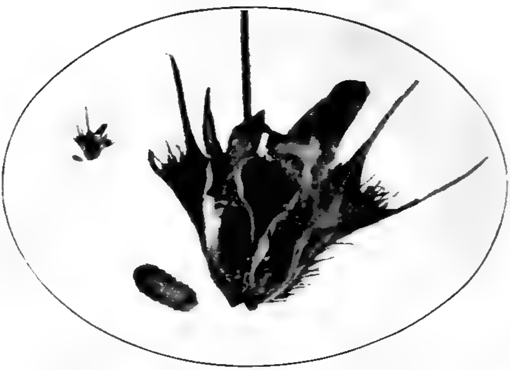

FIG. 274.—The Clover Flower-midge. Section through floret, showing work and larva. Enlarged and natural size. Original.

The adult is a very small, black, four-winged fly. Eggs are laid in the developing seed while it is still tender. The grub eats out the contents of the seed, and transforms in the empty shell. A second brood of flies then emerges and lays eggs in the developing seeds of the second crop of clover. The winter is passed in seeds that have fallen to the ground or in those still remaining in uncut heads.

FIG. 275.—The Clover Seed Chalcid Fly. Adult, greatly enlarged. Original.

Clipping back clover to retard the blooming season will give immunity. The heads will not then be in a suitable stage of growth at the time the adults are on the wing.

FIG. 276.—Work of the Clover Seed Chalcid Fly. Enlarged to six times natural size. Original.

Plant-bugs attacking Cotton Bolls (*Pentatoma ligata* Say, *Nezara hilaris* Say, *Dysdercus suturellus* H. Schf., and others)

Injury to cotton bolls by various plant-bugs often is imperfectly recognized, though the total damage may be severe. In general, all

these insects have strong, sucking beaks, which they insert through the protecting leaves of the young boll. On the outside a close examination will reveal small punctures. Within, the evidence of attack is usually a failure of some or all of the seeds to mature, a shriveling of some parts, or a staining of the lint. Frequently the injury results in complete destruction of the boll.

FIG. 277. — The Cotton-stainer, *Dysdercus suturellus*. Original.

Most plant bugs attacking cotton reach greatest abundance in August or September. They hibernate as adults, largely in old plants, rubbish, and similar shelter.

Remedial measures include destruction of weeds in the spring, to deprive the overwintering bugs of food; early planting, to mature the cotton before the adults are out in greatest abundance; and the burning of old stalks and rubbish early in the fall. Hand picking may be necessary where a species is present in overwhelming numbers.

Cotton Sharpshooters (*Jassidæ*)

Small active insects are found on cotton in the latter part of the season, making tiny punctures in the bolls. They are variously marked and colored, and, examined closely, appear to have abnormally large heads shaped like a broad V, widest where it joins the body. Coming late in the season, their work does not do appreciable damage, and no remedial measures are necessary. In the early part of summer they are to be found on the young foliage of trees.

Plant Lice attacking Wheat Heads

Two closely related species of plant lice, *Macrosiphum granaria* Buck and *Macrosiphum cerealis* Kalt., often are found on wheat and occasionally become so abundant on the growing heads that the grain is stunted and the yield reduced. Both species are yellowish green in color, have long black antennæ and slender, black honey tubes. The

length of the body is one tenth of an inch. In midsummer they live on various grasses, returning to volunteer wheat and oats in the fall.

No means of control are known other than rotation of crops and the destruction of volunteer grains. The natural enemies of these lice ordinarily hold them in check.

CHAPTER XXIII

Insect Pests of Orchard and Small Fruits

The Grape Root-worm (*Fidia viticida* Walsh)

Evidence of the presence of this insect is twofold. Above ground the parent beetle eats characteristic, chainlike holes in the leaves. Beneath ground the grubs which hatch from eggs laid by the beetles gnaw channels and holes in the larger roots and entirely destroy the smaller roots and root hairs. The serious injury is that done by the grubs.

The adult beetle is one fourth inch long, robust, grayish, and covered with very short hairs. It emerges in

Fig. 278. — Roots of grape injured by the Grape Root-worm. Original.

Fig. 279. — Adult of the Grape Root-worm. Enlarged and natural size. Original.

July, feeds on the leaves, and lays eggs in clusters under loose bark on the canes. The young grub, as soon as hatched, drops to the ground, makes its way to the roots, and feeds throughout the summer. When full grown, it is two fifths of an inch long, whitish, with a pale brown head. In the fall the larva goes deeper in the soil, and winters in an earthen cell. In spring it returns to a point two or three inches below the surface of the ground, and in June makes a pupal cell, in which it remains for nearly three weeks. The adults emerge from this in July.

FIG. 280. — The Grape Root-worm. Larvæ. Original.

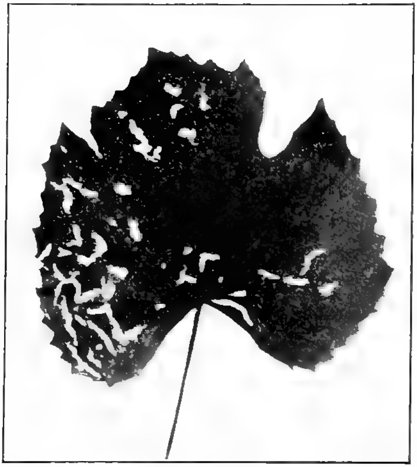

FIG. 281. — Grape leaf showing characteristic work of the adults of the Grape Root-worm. Original.

The most effective means of control is a thorough spraying of the vines the last of June, or as soon as beetles are seen, using arsenate of lead 3 pounds, molasses 1 gallon, and water 50 gallons. The molasses is added because it attracts the beetles and makes the spraying more effective. Stirring the soil beneath the vines about the middle of June will destroy many pupæ in their cells.

White Grubs (*Lachnosterna* spp.)

Strawberry plants often are severely injured by white, thick-bodied grubs which feed on the roots. Entire sections in large strawberry patches may thus be killed out.

This is the same pest that attacks the roots of corn and other field

and garden crops, and is discussed under the heading " White Grubs, " in the section on Insect Pests of Garden and Field Crops, page 109.

The Woolly Apple Aphis (*Schizoneura lanigera* Hausm.)

The woolly aphis is found both on the larger twigs or limbs and on the roots of apple trees. It is characterized by a white, fluffy secretion, looking like little masses of cotton. On the twigs it is found in

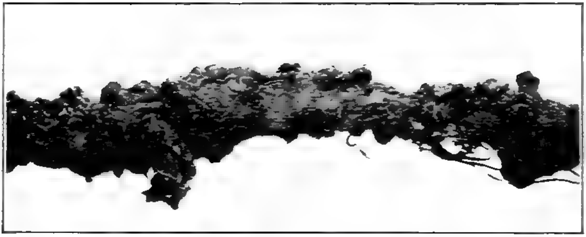

FIG. 282.—Apple root showing characteristic work of the Woolly Apple Aphis. Original.

clusters on the more tender bark, especially at the axils of twigs or where there has been some break in the bark, or on water sprouts. Its work here results in a swelling, which is apt later to crack open. On the roots the attack causes knotty enlargements. The root forms are the more serious, because of interfering with the normal functions of the roots. Attack is especially severe on newly set trees, which are less able to withstand injury.

For the greater part of the year the lice are wingless. Toward the end of summer winged individuals are developed, and these fly to new hosts, where, after a succeeding sexed generation, eggs are laid in crevices of the bark. Hibernation is accomplished both by these eggs and by the subterranean colonies.

For the lice working above ground spray with tobacco extract or with 7 per cent kerosene emulsion. Apply the material with considerable force. For those beneath ground draw back the earth from around the tree to a distance of 2 or 3 feet and a depth of 4

or 5 inches, sprinkle 2 to 6 pounds of tobacco dust on the roots and soil thus exposed, and then replace the dirt removed. Ten per

FIG. 283. — The Woolly Apple Aphis. Cluster of lice on twig. Original.

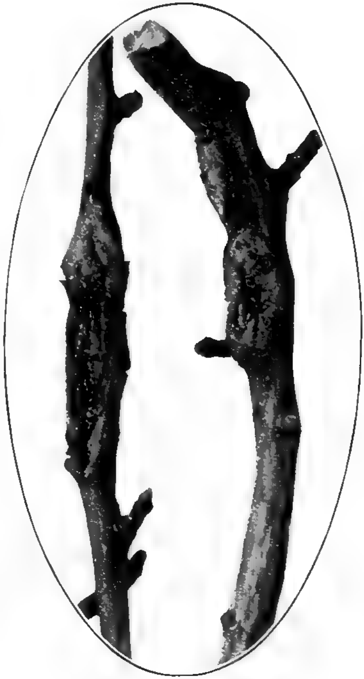

FIG. 284. — Scars on twigs caused by work of the Woolly Apple Aphis. Original.

cent kerosene emulsion may be used instead of the tobacco dust, drawing away the dirt and applying 2 or 3 gallons.

The Grape-phylloxera (*Phylloxera vastatrix* Planch.)

Numerous small, rather spherical galls are formed on the under surface of the leaves of grapes, while on the roots other colonies of the

same species of lice cause swellings which later decay, resulting in the death of the roots. The serious injury is that done by the root-inhabiting forms.

Fig. 285. — Work of the Grape-phylloxera on roots. Original.

On native grapes, in the eastern states, this insect is fairly common, but the roots of these grapes are resistant and no notable damage results. On imported grapes in the Pacific coast states the roots are attacked rather than the leaves, and here the insect is serious, its work resulting in the death of the vines. The lice are small, yellowish, and soft bodied. Winged generations are produced, which spread the species to new fields.

Fig. 286. — Galls on grape leaf caused by the Grape-phylloxera. Original.

In control, in California, imported varieties are grafted on native eastern stocks, thus securing practical immunity. Infested vineyards are treated by flooding, applying water first for 10 days, just after the picking season, again for a similar period a few weeks later, and for a thirty-day period in winter. Vines grown in nearly pure sand are not severely attacked.

The Black Peach Aphis

(*Aphis persicæ-niger* Er. Sm.)

The roots of peach trees often become infested with a soft-bodied, black plant louse. Usually a few of the same lice will be found on the leaves as well, but often the only visible evidence of attack is the yellowing of the foliage and general unthrifty appearance of the tree. Examination will disclose large numbers of these insects clustered on the roots. When mature, they are shining black, and the body is more nearly round than that in most plant lice. The younger forms are brown or reddish.

Treatment consists in drawing away the earth from around the base of the tree and applying 3 or 4 pounds of tobacco dust, replacing the earth afterwards. The lice on foliage may be killed by spraying thoroughly with tobacco extract or 7 per cent kerosene emulsion.

Fig. 287.—The Black Peach Aphis. Lice clustered on root. Original.

The Strawberry Root-louse (*Aphis forbesi* Weed)

Dark greenish or bluish, soft-bodied plant lice infest the roots of strawberries. Where beds are badly attacked, patches are killed out here and there. If a plant that is unthrifty is pulled up, clusters of the lice will be found on the roots, always in company with ants.

The ants are responsible for the root infestation. The lice hatch early in the season from eggs laid in the fall on the stems and leaves by the last generation of the previous year. Two or three generations are passed above ground; then the ants appear and carry the lice to the roots, later transporting them to other plants as the ones infested sicken and die.

An effective treatment consists in covering the plants with straw in

early spring, before growth starts, and burning them over, thus destroying the eggs on the leaves and stems. Beds may be sprayed with tobacco extract after the eggs hatch and before the ants appear, but the application must be thorough. Old beds that will be discarded should always be plowed up in the fall, or, better, burned over in fall or winter.

Fig. 288. — Early-season generation of the Strawberry Root-louse on strawberry leaf and stem. Original.

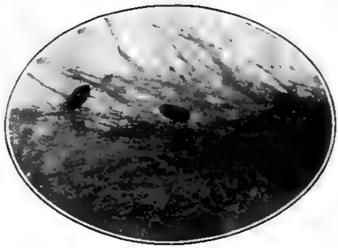

Fig. 289. — Eggs of the Strawberry Root-louse among hairs of leaf-stem. Enlarged. Original.

The Strawberry Crown-girdler (*Otiorhynchus ovatus* Linn.)

Strawberry plants sometimes are girdled an inch or two below the surface of the ground by the young or grubs of this insect. Infested plants tend to wilt down, and if one pulls at the tops, they will be found to come up readily, and to show the work of the insect on the main root a little below the crown.

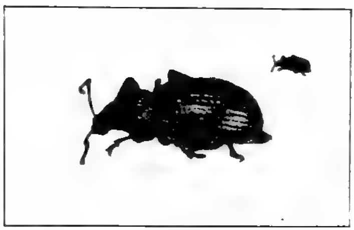

Fig. 290. — Adult of the Strawberry Crown-girdler. Enlarged and natural size. Original.

The adult beetle is a general feeder, and sometimes injures shade trees.

Wild strawberry and the roots of various common grasses are the natural food of the grubs. It is inadvisable therefore to set out plants in ground that has been in sod where examination shows the presence of this grub or similar root feeders in numbers in the soil.

The Cranberry Girdler (*Crambus hortuellus* Hübn.)

Injury by this species is easily recognized, the plants being girdled just below the surface of the sand. The tops show the effects by turning brown and dying. Damage is likely to be confined to restricted areas. Flooding for ten days after picking is an effective means of control.

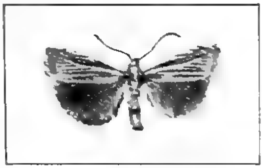

Fig. 291. — Adult of the Cranberry Girdler. Original.

The Grape Root-borer (*Memythrus polistiformis* Harr.)

The softer tissues within the roots of grapes are attacked by a yellowish white borer, $1\frac{1}{2}$ inches long when full grown, and somewhat robust. Infested vines do not usually die, but fail to make thrifty growth.

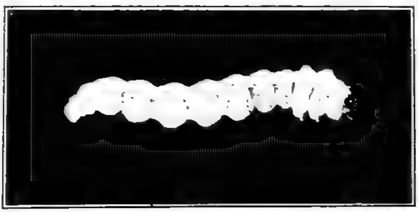

Fig. 292. — The Grape Root-borer. Original.

Fig. 293. — Pupa of the Grape Root-borer. Original.

Two years are required by the borer to reach maturity, and therefore one will ordinarily find

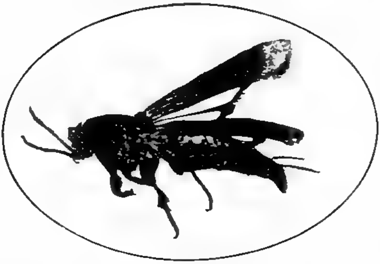

FIG. 294.—Adult of the Grape Root-borer. Enlarged to twice natural size. Original.

two sizes of borers in the roots. When mature, the borer pupates just below the surface of the ground. The adult is a clear-winged moth closely resembling a wasp.

Cultivation in June and July will destroy or bury many of the pupæ. Vines should be stimulated liberally so as to withstand attack. Removal of the larvæ from the roots by hand is sometimes practiced.

Prionid Borers (*Prionus* spp.)

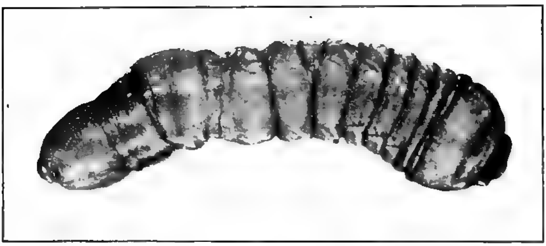

FIG. 295.—A Prionid Borer. Slightly enlarged. Original.

Large, yellowish-white borers, sometimes $2\frac{1}{2}$ inches long, occasionally are found working in or on the roots of grapevines, pear trees, and other fruits. They are the larvæ of dark brown beetles of the genus *Prionus*. When working in a large root, the borer often hollows out the entire inner parts, leaving only the shell. Removal by hand is the only known remedy.

FIG. 296. — Adult of a Prionid Borer, *Prionus imbricornis*. Original.

The Strawberry Crown-borer (*Tyloderma fragariæ* Riley)

The inside of the crown of strawberry plants is hollowed out by a white, thick-bodied grub, one fourth of an inch long, with a brown head.

The adult is a small, dark beetle, one fifth of an inch long, with three darker spots toward the outer edge of each wing cover. It emerges in the fall, hibernates, and lays eggs in the spring. Usually only older plants are infested, because egg laying is over by the time that runners formed in midsummer have made any growth. There is one generation annually.

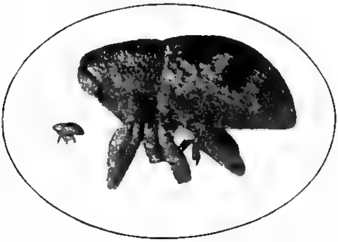

Fig. 297. — Adult of the Strawberry Crown-borer. Enlarged and natural size. Original.

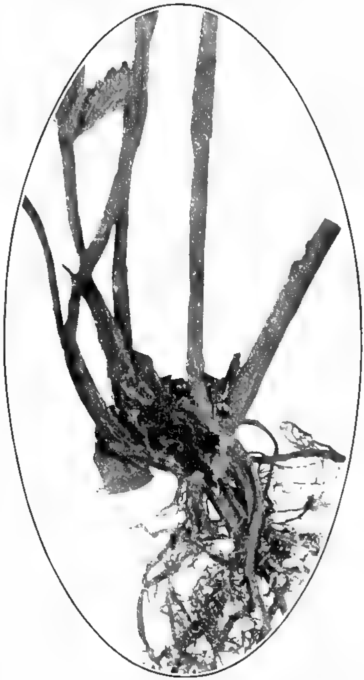

Fig. 298. — Work of the Strawberry Crown-borer. Original.

The adults are unable to fly. Therefore, if old beds are attacked, care should be taken to make new plantings at some distance, and to use only new runners, which will not usually be found infested. In discarded beds the plants should be plowed out at once after the picking season, raked into piles, and burned. This should be done not later than August, in order to kill the insect while still in the crowns. Where beds are moved every two or three seasons, no trouble need be feared from this insect.

The Strawberry Crown Moth (*Ægeria rutilans* Hy. Edw.)

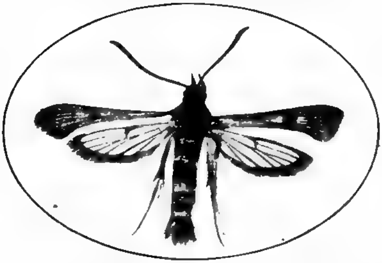

Fig. 299. — The Strawberry Crown Moth. Enlarged to twice natural size. Original.

On the Pacific coast strawberries, blackberries, and raspberries are injured by a whitish, cylindrical borer, three fourths of an inch long when mature, which burrows in the crown of the plant. The adult is a clear-winged moth, resembling a wasp. Remedies include submersion of infested fields, or the removal and destruction of infested plants.

The Raspberry Root-borer (*Bembecia marginata* Harr.)

A pinkish grub works at the base of blackberry and raspberry canes, often girdling the cane just above the crown, causing the death of the shoot. The injury is apt to be noticed in the early part of the growing season, when vigorous canes suddenly wilt. Sometimes the grubs tunnel up in the pith for a few inches, and again they may work through the roots.

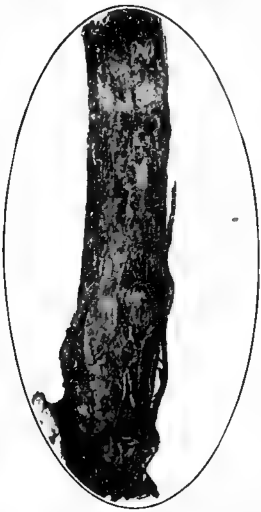

Fig. 300. — Work of the Raspberry Root-borer. Original.

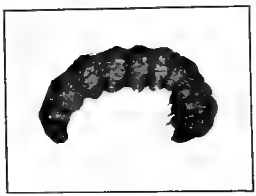

Fig. 301. — The Raspberry Root-borer. Larva, slightly enlarged. Original.

Two years are required for the growth

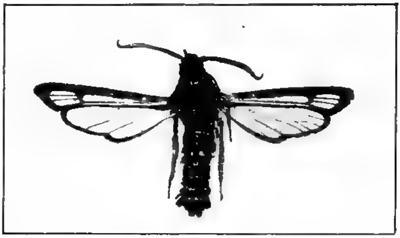

FIG. 302.—Adult of the Raspberry Root-borer. Slightly enlarged. Original.

of the larva. The adults are clear-winged moths, are on the wing in late summer, and lay eggs on the leaves, whence the larvæ make their way to the base of the plant.

Removal and destruction of infested canes and roots each spring is the only remedy.

The Round-headed Apple-tree Borer (*Saperda candida* Fab.)

Apple trees, especially newly set stock, are subject to severe injury by a grub that bores in both sapwood and heartwood toward the base

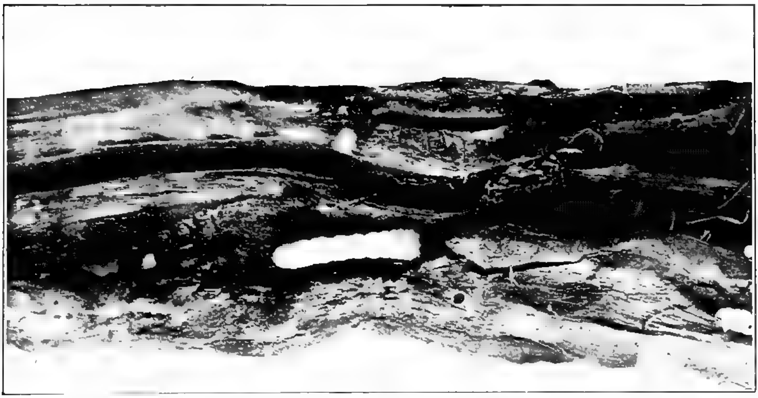

FIG. 303.—Work and larva of the Round-headed Apple-tree Borer. Original.

of the trunk. Its work may be recognized by discolorations of the bark and the presence of castings pushed out of its burrows. The full-grown grub is an inch long, yellowish white, with a small, dark head, and a slightly enlarged, brown first segment.

The parent is a handsome striped beetle. Eggs are laid on the bark,

usually within a foot of the ground, in June and July. The larva requires three years for maturity, feeding first in the sapwood, but later penetrating to the heart of the tree. The food plants include apple, pear, quince, and related wild species.

FIG. 304. — The Round-headed Apple-tree borer. Burrows emerging at base of tree. Adult. Original.

Cutting out with a knife or probing with a soft copper wire are effectual remedies, if carefully done each season. If a wire probe is used, nick the end so that rough barbs will be made and the borer thus drawn out. Mechanical protections tied around the trunk for two to three inches below the ground to a height of two or three feet will prevent egg laying. For this purpose one may use wood veneer, heavy paper, or even old newspapers, which usually will last through one season. Pure white lead and linseed oil may be painted on the trunks of apple trees, but ready mixed paint must not be used, since it may contain other oils that are injurious. Protective washes are of some benefit, but need to be renewed occasionally, and will not wholly prevent attack, though they will lessen the number of borers.

The Flat-headed Apple-tree Borer (*Chrysobothris femorata* Fab.)

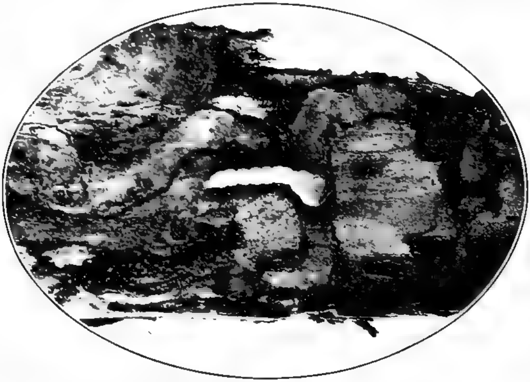

FIG. 305. — The Flat-headed Apple-tree Borer. Work and larva. Original.

The flat-headed apple-tree borer works only in the sapwood, often well up on the trunk, and completes its life round in one year. The grub has a flattened and enlarged segment just back of the head. Its parent is a small, metallic colored beetle. The food plants include apple, pear, peach, and various forest trees such as oak and maple.

FIG. 306. — Adult of the Flat-headed Apple-tree Borer. Original.

Eggs are laid in June and July. The grub makes shallow burrows, for the most part just under the outer bark. The insect hibernates as a grub in the burrows.

Remedies are the same as for the round-headed apple-tree borer, but mechanical protectors must inclose the entire trunk.

The Peach-borer (*Sanninoidea exitiosa* Say)

An exudation of gum, often mixed with sawdust or frass, usually close to or just beneath the surface of the ground, is the outward evi-

dence of the work of the peach-tree borer. This may be observed at any time of year, but the gum is fresh in late summer or very early

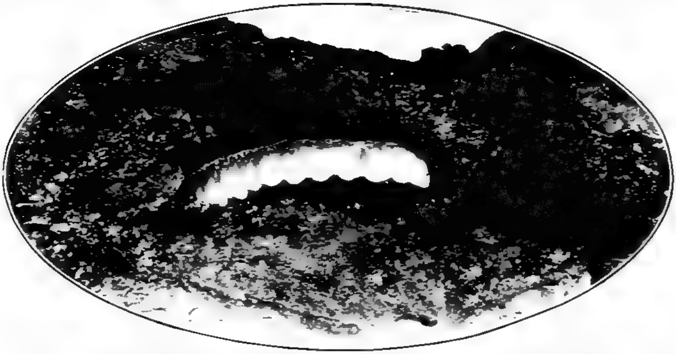

Fig. 307. — The Peach-borer. Larva in burrow. Slightly enlarged. Original.

in the spring. If one will take a sharp knife and cut through the bark, one will find a burrow running in the sapwood, and at its end a yellowish or pinkish grub, with brown head. The length of a full-grown grub is about one inch. Peach trees are much weakened by the attack, and if several borers are present, the tree may be killed. Cherry and plum trees are infested to some extent by the same borer.

Fig. 308. — Cocoon of the Peach-borer. Original.

The adult is a moth, but its clear wings give it much the appearance of a wasp. In the female only the hind wings are clear. Its general color is deep blue. The abdomen of the female is marked by an orange band.

Eggs are laid in May, June, or July, directly on the bark, usually near the ground. The young grub works entirely in the sapwood, from the time when first hatched until the early part of the following summer, resting and remaining dormant during the winter months and resuming activity in the spring. The moths emerge from May until July. There is one generation each year.

A common remedial measure consists in cutting out the grub with a sharp knife. This is best done in the fall or very early in the spring. The burrows may be probed with a soft wire nicked so as to form

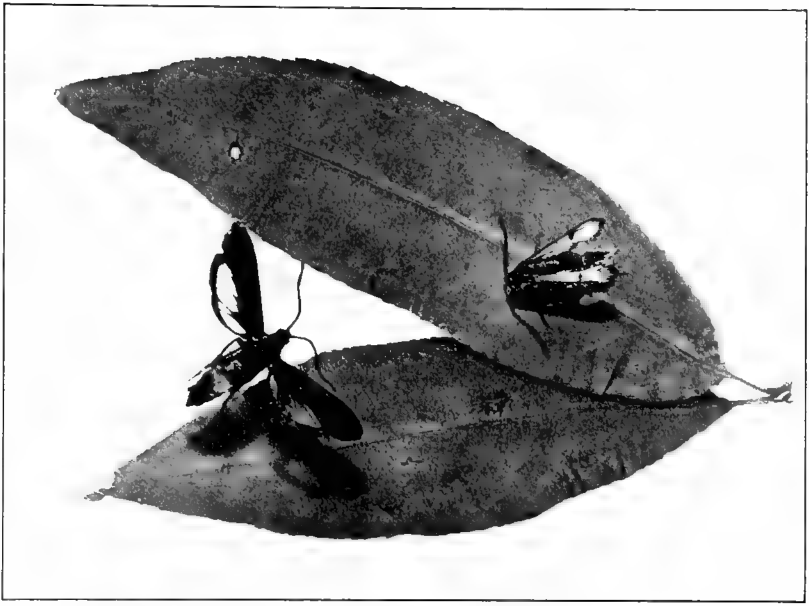

FIG. 309.—Adults, female and male, of the Peach-borer. Original.

rough barbs; the grub or a piece of it will then be drawn out with the wire.

The best preventive measure consists in drawing up earth around the base of the tree in early spring, removing it toward the latter part of summer. The moths will not lay eggs on the trunk when this is done. The trunk may be protected with a cylinder of paper tied around it, extending up 12 or 15 inches and down into the ground an inch or two. Washes applied to the tree to prevent egg laying are only partly successful.

The Lesser Peach-borer (*Synanthedon pictipes* G. and R.)

Old or weakened trees are apt to be attacked by this borer, which works in the soft, growing tissue anywhere in the trunk, from the ground to the main branches. The same insect also attacks plum, cherry, and wild cherry.

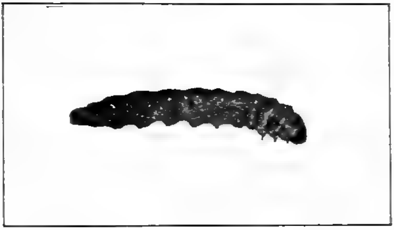

Fig. 310. — The Lesser Peach-borer. Slightly enlarged. Original.

The worm itself has much the appearance of the common peach borer, but is smaller, rarely being over four fifths of an inch long, when full grown. In the South there are two generations; in the North, only one. The winter is passed by the larva in the trunk, and pupation takes place early in the spring. The adult is a clear-winged moth. Eggs are laid on the trunk, especially in cracks or crevices.

Fig. 311. — The Lesser Peach-borer. Pupa protruding from crack in bark. Original.

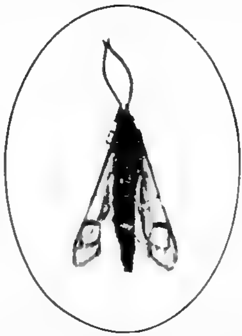

Fig. 312. — Adult of the Lesser Peach-borer. Slightly enlarged. Original.

The best preventive measure is to keep trees growing vigorously and promptly to treat with white lead any chance wounds in the bark.

Where borers are present, cut them out with a knife, or probe the burrows with a soft copper wire. Knife wounds should be painted with white lead.

The Shot Hole Borer (*Eccoptogaster* (*Scolytus*) *rugulosus* Ratz.)

Plum, pear, apple, peach, and cherry are attacked by this tiny insect. The outward evidence of injury is seen in numerous round holes in the bark, each hole clean-cut, about one sixteenth of an inch in diameter, as if the trunk or limb had received a charge of bird shot. As a rule only trees are attacked that have been weakened from some cause or other.

If a piece of bark is removed where the holes are numerous, shallow galleries will be found beneath. These are of characteristic form. A central gallery, one or two inches long, runs parallel with the axis of the trunk or limb, while from this many other galleries diverge, quite small at the start but growing rapidly larger.

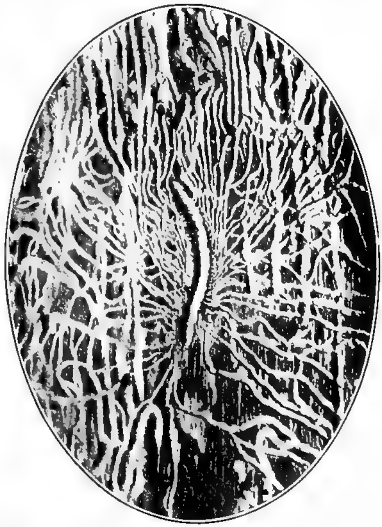

Fig. 313. — Burrows of the Shot Hole Borer, disclosed by removal of bark. Original.

A small, dark beetle makes the main gallery as its brood chamber, laying its eggs in pockets along each side. Grubs hatch from these, bore the diverging channels as they grow, and finally come out as adult beetles, cutting round emergence holes through the bark.

In northern sections there are two generations each year; in the South there are three.

To control, remove and burn dead or dying trees in which the insect is breeding in large numbers. They will invariably spread from these

to others in the orchard that chance not to be making vigorous growth. Trim back and fertilize trees only moderately attacked. Apply a coat of thick carbolated whitewash in early spring, again in June, and again in August. Use 1 pint of crude carbolic acid to 10 gallons of the whitewash.

Fig. 314.—The Shot Hole Borer. Section of bark over burrows, showing exit holes. Original.

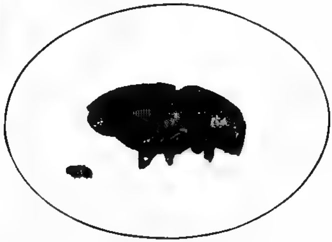

Fig. 315.—The Shot Hole Borer. Adult. Enlarged and natural size. Original.

The Peach Bark-beetle

(*Phlœophthorus liminaris* Harr.)

Injury is similar to that of the shot hole borer. The bark of peach, plum, or cherry trees is peppered with many small, round holes. If the tree is not already too much weakened, considerable gum will flow from these holes. Removal of a section of bark will show the difference between the work of this insect and that of the shot hole borer: the main channels made by this pest run around the axis of the trunk or limb, while those of the shot hole borer run parallel to it.

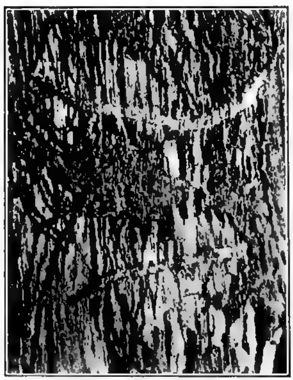

Fig. 316.—Burrows of the Peach Bark-beetle. Original.

There are two generations each year. The adult beetles hibernate in cells dug out in the inner bark, often in healthy trees. In the spring they come out, select weakened trees, and bore the main channel just under the bark, laying eggs in the sides of this channel. The grubs work out at right angles, making diverging burrows. A second lot of beetles appear in August, construct channels as before, and from their grubs come the hibernating adults.

FIG. 317.—The Peach Bark-beetle. Adult. Enlarged and natural size. Original.

Control measures are the same as those recommended for the shot hole borer.

The Currant Borer (*Ægeria tipuliformis* Clerck)

Currants or gooseberries are injured or killed by the work of this borer. The infested plants usually show the attack first by their unthrifty appearance; the next season they fail to leaf out.

The borer is a yellowish grub, half an inch long when full grown. It works in the center of the cane, spends the winter within the

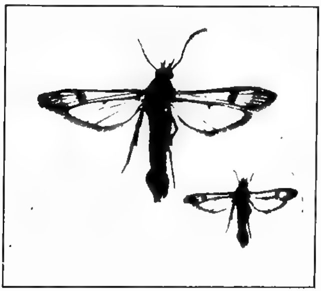

FIG. 318.—Adult of the Currant Borer. Enlarged and natural size. Original.

FIG. 319.—Work of the Currant Borer. Original.

cane near its base, resumes work in the spring and soon transforms. The adult is a clear-winged moth, and emerges in June through a hole in the cane cut by the grub before transforming.

Removal and destruction of infested canes in the fall or spring is the only remedy.

The Red-necked Cane-borer (*Agrilus ruficollis* Fab.)

Fig. 320. — Work of the Red-necked Cane-borer. Original.

A whitish grub, one half to three fourths of an inch long, with an enlarged head, bores in the canes of blackberry and raspberry. In the former the burrows make a spiral girdle just beneath the bark, and cause a slight swelling, resulting in the death of the cane the following season. The galls occur usually within two or three feet of the base of the cane. In raspberries no serious damage is done.

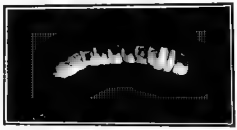

Fig. 321. — The Red-necked Cane-borer. Larva, enlarged to twice natural size. Original.

The adult is a rather slender beetle, one third of an inch long, with dark wing covers and a copper-colored thorax or "neck." Eggs are laid in June and July at the base of leafstalks. The grubs pupate within the canes, above the galls, and remain there until the following May.

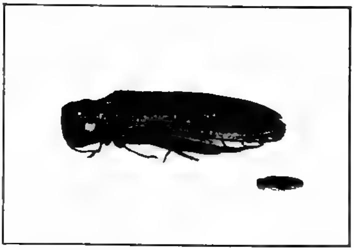

Fig. 322. — Adult of the Red-necked Cane-borer. Enlarged and natural size. Original.

Before May 1 remove and destroy infested canes, including those of wild blackberry near at hand.

The Raspberry Cane-borer (*Oberea bimaculata* Oliv.)

Raspberry or blackberry shoots attacked by this insect wilt toward the end, and often bend sharply over. Within will be found a slender grub, which later bores down through the cane, pupates in the base of it, and emerges the following June as a slender, dark beetle, with long antennæ and yellow thorax. The grub, when full grown, is one inch long and has a small brown head. Two years are required for the entire life round. If a cane that has wilted is examined closely, it will be found that the beetle has girdled it at two points with a row of punctures. The egg is laid between these two rows.

Fig. 323 — Adult of the Raspberry Cane-borer. Slightly enlarged. Original.

Fig. 324.—Work of the Raspberry Cane-borer. Original.

Remove and destroy the upper parts of infested canes as soon as the presence of the insect is discovered. If this work is delayed until late summer, it is necessary to remove the entire cane in order to get the grub.

The Raspberry Cane-maggot (*Phorbia rubivora* Coq.)

The tips of the young shoots wilt and droop as when attacked by the cane-borer described above, but the canes do not show the character-

istic punctures and do not bend sharply at one place. The drooping is due to the presence of a maggot which burrows in the pith of the cane and more or less girdles it from the inside.

The adult is a two-winged fly, and emerges in the spring. The insect remains as a pupa within the cane over winter. Cut and destroy infested canes as soon as the wilting of the tips is observed.

The Currant Stem-girdler (*Janus integer* Nort.)

Currant shoots wilt and bend over sharply, and usually the tip soon breaks off and falls to the ground, leaving a square-cut stub. Within the remaining stalk, a few inches below the cut, will be found a light yellow larva half an inch long, wider toward the head, and provided with a forked spine at the hind end.

The parent insect is a sawfly. The girdling of the stem is done by the adult just after depositing its egg in the shoot and at a point just above the egg. The larva hibernates in the main shoot. It seldom burrows more than six inches below the stub.

Infested shoots should be cut off eight or ten inches below the stub.

FIG. 325. — Work of the Grape-cane Gall-maker. Original.

The Grape-cane Gall-maker (*Ampeloglypter sesostris* Lec.)

A tiny snout beetle, one eighth of an inch long, sometimes injures grape canes in the

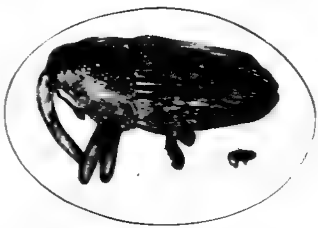

FIG. 326. — Adult of the Grape-cane Gall-maker. Enlarged and natural size. Original.

spring by puncturing the new wood. The part injured later develops into a gall an inch or an inch and a half long, which shows a deep scar on one side. Eggs are laid in the punctures, and grubs develop in the pith of the cane. The adults come out in late summer, and hide in rubbish over winter.

Since the beetles feed to some extent on the leaf and stem tissues, they may be poisoned by spraying with arsenate of lead or Paris green. Galls should be cut off and destroyed before the time of emergence of adults in late summer.

The Grapevine Girdler (*Ampeloglypter ater* Lec.)

This insect in its adult stage is similarto the grape-cane gall-maker, but its color is black. It injures terminal shoots by girdling them, so that the end of the shoot later falls to the ground. The young or grub develops within the shoot. The adult emerges in the fall and hibernates in the leaves or trash.

Spraying with arsenate of lead or Paris green in May or June will kill the beetles. In early summer cut off the ends of canes showing the characteristic girdling, making the cut a few inches below the girdle.

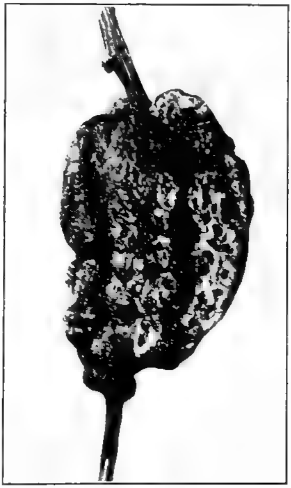

Fig. 327. — The Blackberry Pithy-gall. Original.

The Blackberry Pithy-gall (*Diastrophus turgidus* Bass.)

Curious, hard enlargements of the canes of blackberries are caused by small, fleshy larvæ which hatch from eggs laid by a black gall-fly. Several larvæ inhabit each gall, remaining within it as pupæ over winter. The species is not abundant enough to be a pest, but galls should be removed whenever found.

The Peach Twig-moth (*Anarsia lineatella* Zell.)

In the spring, about the time of blooming of peach trees, terminal clusters of leaves here and there wilt, and the twigs soon die. Close examination will show that a tiny borer has been at work in the twigs, eating out the inner substance for an inch or so, or digging out a hole in one side. The larva itself, if discovered, will be found to be quite small, with a dark head and dark terminal segment.

FIG. 328. — Work of the Peach Twig-moth. Original.

Shortly the little gray moths, expanding about half an inch, are about, and a second brood is on the way. Later there is still another brood. The larvæ of these later generations often work in the young fruit, causing drops of gum to exude.

The winter is passed as a larva, hidden away in a little chamber just under the outer bark, in the axil of a new shoot or bud. To control, spray with lime sulphur, at the time that the buds are first swelling, so as to kill the larva within its winter home. If this treatment is omitted, spray with arsenate of lead, 4 pounds to 50 gallons of water, just as the

buds first begin to open. The later treatment is designed to poison the borer when it begins work on the twigs.

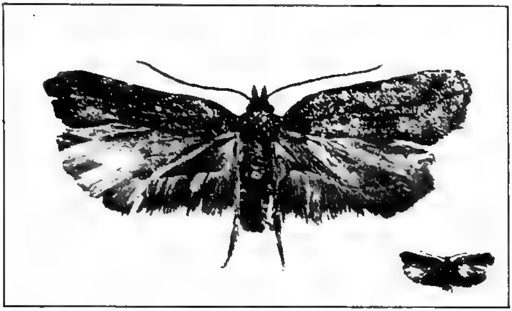

Fig. 329. — Adult Peach Twig-moth. Enlarged and natural size. Original.

The Shot-borer (*Xyleborus dispar* Fab. (*pyri* Peck))

A tiny black beetle, one tenth of an inch long, bores into twigs or small branches in late summer and deposits eggs. The resulting grub burrows in the twig, becoming full grown the following June. In the spring close observation will reveal one or more round punctures, a twentieth of an inch in diameter. Infested twigs are apt to wilt and should be cut off and burned as soon as the wilting is noted.

Fig. 330. — Work of the Shot-borer. Original.

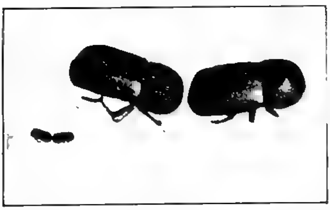

Fig. 331. — Adults of the Shot-borer. Enlarged and natural size. Original.

Fig. 332. — Section through branch, showing work of the Shot-borer. Original.

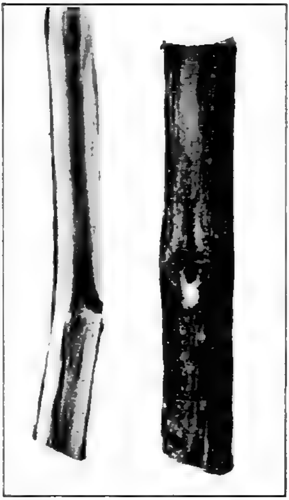

FIG. 333. — Work of the Apple Twig-borer. Original.

The Apple Twig-borer

(*Schistoceros hamatus* Fab.)

In early summer the twigs of apple, cherry, or pear, or the canes of grape may show characteristic little tunnels, beginning just above a shoot or bud, and extending down a short distance in the main stem or branch. They are the work of a small, dark brown beetle, about one third of an inch in length, which soon deserts its temporary burrow and is not likely to be seen.

The insect breeds in diseased wood, hibernating within the same. It is troublesome in the neighborhood of piles of recent trimmings and the like, and these should be removed and destroyed. The tunnels in the twigs of fruit trees are made apparently in feeding, or for temporary shelter.

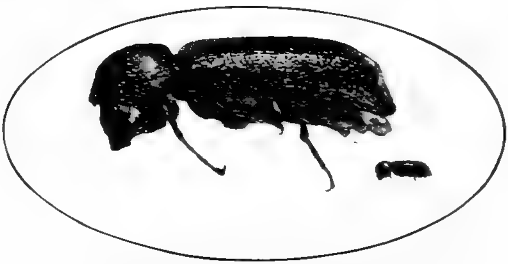

FIG. 334. — The Apple Twig-borer, enlarged and natural size. Original.

The Twig-girdler (*Oncideres cingulata* Say)

Pecan trees and others are injured by a dark gray beetle half an inch long, which girdles twigs or smaller branches. A clean cut is made

by the beetle, usually deep enough for the twig to break entirely off. The beetles are at work in late summer.

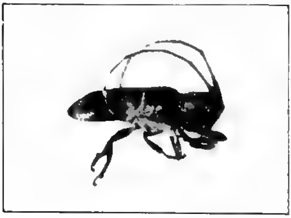

FIG. 335. — The Twig-girdler. Original.

After girdling a twig the beetle lays eggs in it, and the larvæ bore in the twig, becoming full grown the following summer. There is only one generation each year.

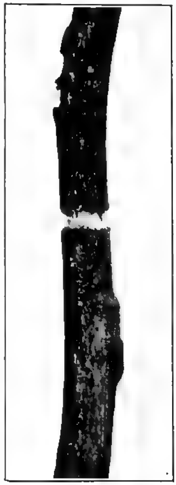

FIG. 336. — Work of the Twig-girdler. Original.

Where young trees are seriously attacked, the beetles should be hunted out and destroyed. All twigs cut off should be gathered up and burned.

FIG. 337. — Work of the Twig-pruner. Original.

The Twig-pruner

(*Elaphidion villosum* Fab.)

Various kinds of fruit and shade trees sometimes suffer the loss of terminal twigs, girdled by this insect. The work is done by the larva or grub of an elongate, dark brown beetle, a half to three fourths of an inch long. Eggs are laid in the twigs in July, and the grub feeds within, finally gnawing a circular groove as far as the outer bark, so that the twig breaks off, taking the grub with it. The fallen twig then serves as its

FIG. 338. — Adult of the Twig-pruner. Original.

FIG. 339. — Punctures made by Tree Crickets. Original.

home until the following spring, when it transforms and comes out as an adult. The remedy is to gather and destroy the fallen twigs.

Tree Crickets (*Œcanthus* spp.)

Small, light green, and rather slender crickets make long rows of punctures in the canes of raspberries and blackberries, and in tender twigs of fruit trees, the injury often resulting in the death of the cane or twig. If a twig showing these characteristic punctures is split, it will be found that the holes were made as a place to deposit eggs. The species usually responsible is *Œcanthus nigricornis* Walk.

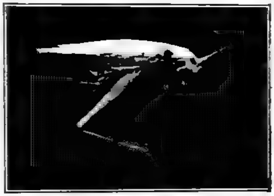

FIG. 340. — A Tree Cricket. Original.

The punctures are made in the latter part of summer, and the eggs hatch in the spring. There is one brood in the North, but two in the South. Both young and adults feed on other insects, and should be regarded as beneficial.

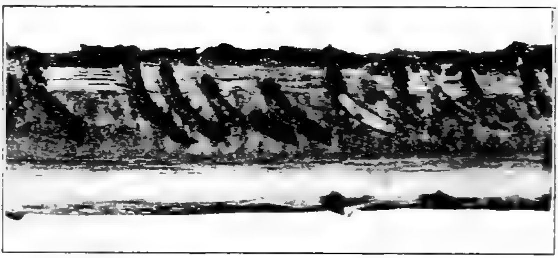

FIG. 341. — Section through twig, showing punctures of Tree Crickets in detail. Enlarged. Original.

Injured twigs may be removed in early spring or in the course of winter pruning.

The Buffalo Tree-hopper (*Ceresa bubalus* Fab.)

The twigs and smaller limbs of orchard trees sometimes show regular rows of oval scars, due to the egg-laying punctures of a curious little insect, the buffalo tree-hopper. The scars do not heal, and, if numerous, weaken the twigs.

The insect that makes the punctures is triangular in shape, light green in color, three eighths of an inch long, and has a two-horned enlargement at the front of its body. The young that hatch from the eggs do not feed in or on the twig, but on various weeds.

Fig. 342.— The Buffalo Tree-hopper. Enlarged and natural size. Original.

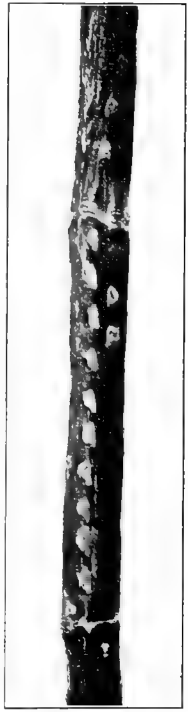

Fig. 343. — Work of Buffalo Tree-hopper. Original.

Fig. 344. — Work of the Periodical Cicada. Original.

In control, weeds should be kept down in the orchard, and twigs that show many of the egg-laying slits may be pruned in winter.

The Periodical Cicada (*Tibicen septendecim* Linn.)

Occasional injury to twigs of fruit trees is recorded due to egg-laying punctures of the periodical cicada. This insect is closely related to the "dog-day cicada," or "locust," which is heard

sounding its long, high-pitched note in summer. Usually the only notable cases of injury are to newly set fruit trees, which are so small

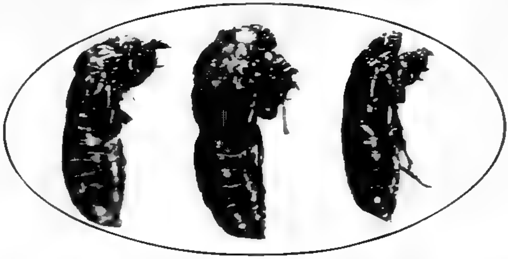

Fig. 345. — Emergence of Adult Cicada from pupal skin. Original.

as to make the work in the twigs really serious. The injury takes the form of a row of regular punctures in the twig, each puncture with a frayed or torn margin.

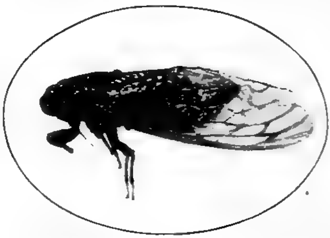

Fig. 346. — The Periodical Cicada. Original.

Definite "broods" of this insect exist in various parts of the country, and these have been studied and mapped so that the coming of the adults can be predicted. The immature stages of the cicada are passed in the soil, and either 13 or 17 years are required for this part of the insect's growth, depending on the section and the brood. At the end of this time the adults suddenly appear in large numbers, lay eggs, and another life cycle begins, as before.

Bordeaux mixture appears to act as a repellent when sprayed on young trees that are threatened with injury.

The San José Scale (*Aspidiotus perniciosus* Comst.)

This serious pest of fruit trees, shade trees, and ornamentals is an insidious insect, and seldom is recognized until it has gained a foothold and has already caused marked injury. The first evidence of its presence usually noted is the weakening or dying of twigs. On further

examination such twigs are found to have a scurfy or ashy look, the bark being crusted with hundreds of minute scales, no larger than a very small pin head. If a sliver of the outer bark is cut away, the inner, soft bark will be found to show more or less reddish discolora-

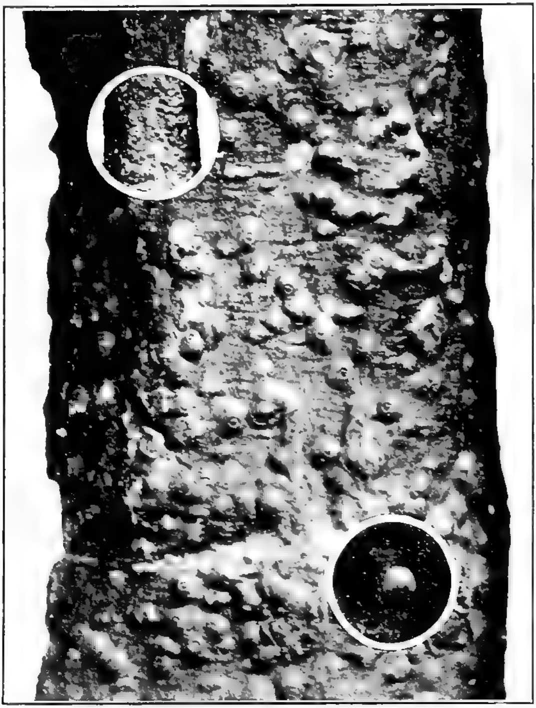

Fig. 347. — The San José Scale. Above, natural size. Center, enlarged. Below, a single scale, enlarged. Original.

tion. On peach trees the scale is apt to gain a foothold first on the larger limbs, rather than the small twigs. When the scales are quite numerous, they will be found also on the leaves and fruit, as well as the bark. On the fruit of apple, peach, or pear a reddish discoloration surrounds isolated scales. Peach trees frequently are killed by the

insect in three years. Apple and pear trees, and various ornamental shrubs, usually manage to exist for some time longer.

If a hand lens is used for closer examination, it will be found that each scale is circular in shape, rather flat, dark in color, and has in its center a small raised spot, like a nipple, surrounded by a slight depression. Smaller, oval scales represent the males.

FIG. 348. — Work of San José Scale on pear. Original.

There are several generations each season. The species lives through the winter as half-grown females. With the coming of warm weather these complete their growth, the tiny winged males appear, and in a few days each female begins giving birth to exceedingly small, living young. The latter crawl about over the bark for a few hours, then settle down, insert their sucking beaks, and soon are covered with a protecting wax scale. They do not move thereafter. The total progeny of a single female in one season is enormous.

The insect is especially likely to be introduced on nursery stock, and the greatest care should be taken in the purchase of trees for an orchard. If stock has been properly fumigated with hydrocyanic acid gas, the scales will be killed.

Treatment of trees or shrubs consists of spraying in the dormant season with lime-sulphur solution. The best time of application is in the spring, just before the buds swell. Where the infestation is severe, it is well to spray in the fall, after the leaves have dropped, and again in the spring.

For small shrubs, and the like, if it is not desired to use the lime-sulphur spray, a solution of whale-oil soap, 2 pounds to 1 gallon of water, may be applied in winter. The potash soap should be used.

Several other species closely resemble the San José scale, and on superficial examination can hardly be distinguished from it. They have not, however, so distinct a ring and nipple.

The Putnam's Scale (*Aspidiotus ancylus* Putnam) infests many kinds of fruit and shade trees. It has one generation annually.

The Cherry Scale (*Aspidiotus forbesi* Johns.) is found on the bark of cherry and other fruit trees. It is lighter in color than the San José scale.

The European Fruit-scale (*Aspidiotus ostreæformis* Curt.) attacks principally plums, but occasionally other fruits, except the peach. It produces several generations annually and is often a serious pest.

Fig. 349. — Branch incrusted with Putnam's Scale. Original.

For all of these the best treatment is a winter spraying with lime sulphur.

Fig. 350. — Cherry Scale. Enlarged to seven times natural size. Original.

The Oyster-shell Scale (*Lepidosaphes ulmi* Linn.)

The shape of this scale is quite like that of a narrow, miniature oyster shell. It is about one eighth of an inch long and is easily observed without a lens. It commonly infests a great variety of deciduous trees and shrubs, and when very abundant, is capable of causing the death of its host.

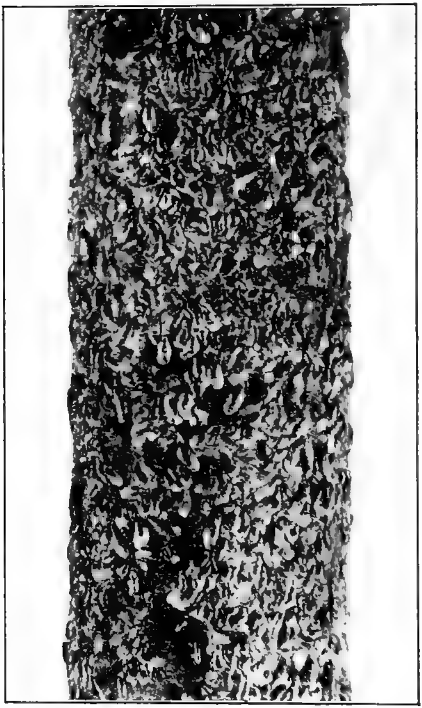

Fig. 351. — Oyster-shell Scale. Enlarged to twice natural size. Original.

The young scales appear in May or June, crawl about over the bark for six or eight hours, and then insert their beaks, settle down, and secrete the wax covering under which they remain for the rest of their life. The males are winged. Eggs are laid in fall, beneath the scale covering the female, and remain there until the next spring. In the South there are two broods; in the North one.

Regular, annual spraying in winter with lime sulphur for San José scale will hold this insect sufficiently in check. For direct, remedial treatment of badly infested trees this wash is not sufficiently active or dependable. The only remedies that may be depended on are a spraying in early spring with linseed oil emulsion; or an application of 12 per cent kerosene emulsion at the

time that the young are hatching. The date for the latter must be determined by close watching.

FIG. 352. — Oyster-shell Scale. Greatly enlarged. Original.

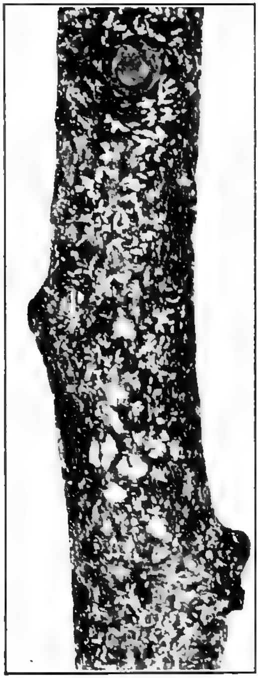

FIG. 353. — Scurfy Scale. The larger are females; the smaller are males. Slightly enlarged. Original.

The Scurfy Scale

(*Chionaspis furfura* Fitch)

The scurfy scale is found principally on apple, but occasionally on pear, peach, cherry, currant, and gooseberry. The scale of the female is small, flat, whitish, and broadly oval. With these will be found the scales of the male, which are smaller, narrow, and longitudinally ridged.

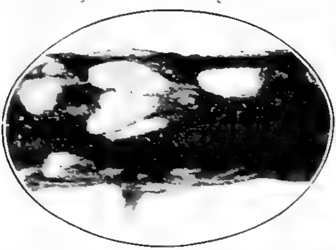

FIG. 354. — Scurfy Scale. Greatly enlarged. Original.

There is one generation annually. Eggs are laid in the fall, beneath the scale of the female, and from these hatch the minute young, in the spring. Only the male is winged.

Spraying with lime sulphur in winter, as for San José scale, will control this pest.

The Rose Scale (*Aulacaspis rosæ* Bouché)

Roses, blackberries, and raspberries frequently become infested with white scales which cover the canes. The individual scales, when full grown, are about one tenth of an inch long, thin, flat, and snowy white. There may be three or more generations in a year.

Judicious pruning will help to hold them in check. Lime sulphur may be used as a winter spray. Or, spray in winter with whale-oil soap, 1 pound to 1 gallon of water.

Fig. 355.—Cottony Maple-scale. Original.

The Cottony Maple-scale (*Pulvinaria vitis* Linn.)

This large and easily recognized scale attacks grape vines and various fruit and shade trees. It is conspicuous in early spring, when the fluffy, cottony secretion containing the eggs is pushed out from under the body of the female. There is one generation annually, the female over-wintering on the bark.

The means of control is to spray with 10 per cent kerosene emulsion when the young are hatching in the spring.

The European Fruit Lecanium (*Lecanium corni* Bouché)

The smaller limbs and twigs of fruit trees are attacked by a species of large scale, one eighth of an inch long and nearly hemispherical. When young, it is yellowish, but when older, is dark and shiny. The upper surface of the insect is hardened, thus protecting the softer parts beneath; in other words, the scaly covering

is really a part of the insect itself and is not detachable as with the San José or oyster-shell scales.

FIG. 356.—The European Fruit Lecanium. Enlarged to twice natural size. Original.

The best remedial measure is a winter spraying with crude oil emulsion at 12 per cent strength or distillate oil emulsion at 5 per cent strength. Distillate oil emulsion is prepared by dissolving 8 pounds of whale-oil soap in 3 gallons of hot water, adding 5 gallons of distillate oil and at once pumping the mixture back on itself. To dilute for a 5 per cent strength add 1 gallon of emulsion to $11\frac{1}{2}$ gallons of water.

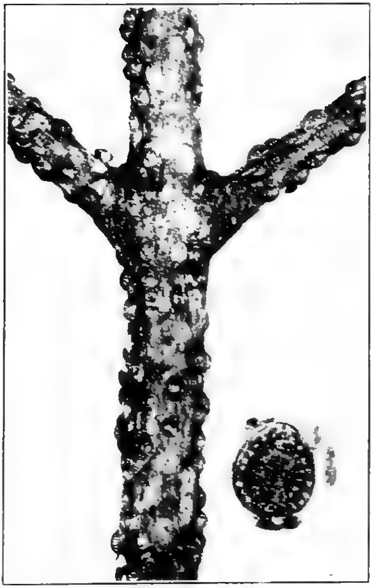

FIG. 357.—Terrapin Scale. Below, a single scale, enlarged. Original.

The Terrapin Scale (*Eulecanium nigrofasciatum* Perg.)

The terrapin scale is nearly hemispherical, about one twelfth of an inch long, nearly as wide and high, and reddish in color. The surface is marked with darker, radiating spots or streaks, and usually there is a series of shallow depressions near the margin. The food plants include peach, apple, plum, cherry, quince, pear, and various shade trees.

The scale is difficult to kill. The best remedy is spraying with 20 per cent kerosene emulsion in spring, just before growth starts. Do not apply so much liquid that it will run down the trunk of the tree.

The Spotted Pelidnota (*Pelidnota punctata* Linn.)

FIG. 358.—The Spotted Pelidnota. Original.

Heavy-bodied, slow-moving beetles sometimes are found in considerable numbers on the leaves of grapes. They are an inch long, golden yellow, and each wing cover is marked with three small black dots, widely separated. The immature stages are passed in rotting wood. The beetles are usually controlled by hand picking, but may be poisoned with applications of Paris green or arsenate of lead.

FIG. 359.—The Light-loving Anomala. Enlarged to twice natural size. Original.

The Light-loving Anomala
(*Anomala lucicola* Fab.)

Occasionally the foliage of grapes is riddled by brownish beetles, one third of an inch long, in shape and appearance like the common June beetles, but smaller. The larvæ live in the soil and are not injurious. The beetles are readily killed by spraying with arsenate of lead or Paris green.

FIG. 360.—*Anomala marginata.* Enlarged. Original.

An allied species, *Anomala marginata* Fab., is found in the South, where it sometimes destroys the foliage of apples, grapes, raspberries or blackberries. It is half an inch long and light brownish in color.

FIG. 361.—*Anomala undulata.* Enlarged. Original.

Still another species with similar habits is *Anomala undulata* Mels., one third of an inch long, yellowish in color, and marked with black.

The above are pests only at compara-

tively rare intervals. Prompt application of Paris green or arsenate of lead will poison them.

The Cherry Leaf-beetle (*Galerucella cavicollis* Lec.)

An oval, red beetle, one fourth of an inch long, with black legs and antennæ, feeds on the leaves of cherry, plum, and peach, and when numerous riddles the foliage. The larvæ also feed on the leaves. The pupal stage is passed in the ground, and there are two broods annually. The remedy is prompt spraying with arsenate of lead or Paris green.

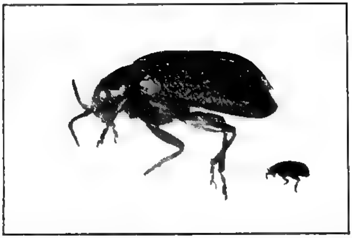

Fig. 362. — The Cherry Leaf-beetle. Enlarged and natural size. Original.

The Strawberry Leaf-beetle (*Typophorus canellus* Fab.)

A chunky, dark beetle, one eighth of an inch long, with four oblique, black patches on its wings, occasionally appears in large numbers in strawberry fields early in the season, and riddles the leaves. The larvæ or grubs which follow shortly are small and thick bodied, and feed on the roots of the plants. The beetles hibernate as adults.

Fig. 363. — Work of the Strawberry Leaf-beetle. Original.

Prompt spraying with Paris green or arsenate of lead will check the beetles.

Another species with somewhat similar feeding habits, *Colaspis*

brunnea Fab., is occasionally in evidence on strawberry or grape, and rarely on garden or field crops. It is yellowish, oval, rather convex,

FIG. 364. — Larva of the Strawberry Leaf-beetle. Enlarged and natural size. Original.

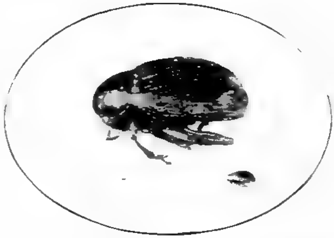

FIG. 365. — The Strawberry Leaf-beetle. Adult, enlarged and natural size. Original.

and about one fifth of an inch long. The grubs feed on the roots. There is a single brood annually. Arsenicals will poison the adults.

FIG. 366. — Pupa of the Grape Colaspis. Enlarged and natural size. Original.

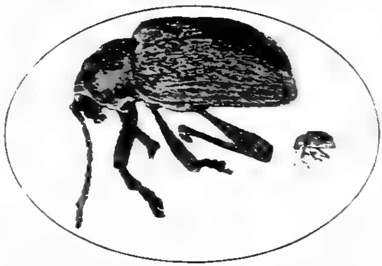

FIG. 367. — The Grape Colaspis. Adult, enlarged and natural size. Original.

The Grape Flea-beetle (*Haltica chalybea* Illig.)

Early in the growing season, the swelling buds of grapes are eaten into and destroyed, and as the tender leaves unfold they are riddled. The beetles which are responsible for this damage are small, steely-

blue insects, one eighth to one fifth of an inch long, and rather broad. They are able to fly readily and jump quickly.

Eggs are soon laid, and the larvæ feed on the surface of the leaves, leaving the veins untouched. A pupal stage is passed in the ground, and there is a second generation in midsummer, but damage by this later brood is not particularly noticeable because the foliage is relatively more abundant.

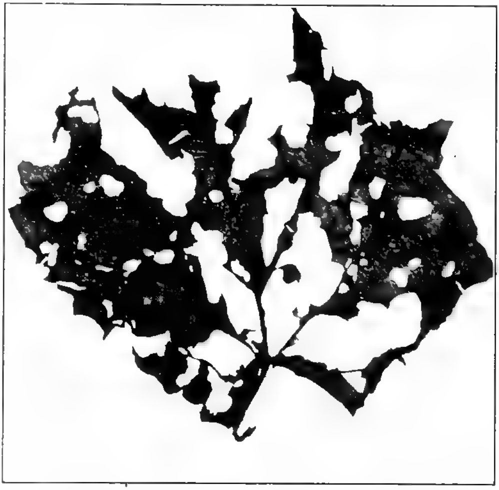

Fig. 368.—Work of the Grape Flea-beetle. Original.

To control, spray with 4 pounds of arsenate of lead and 1 gallon of cheap molasses to 50 gallons of water. Apply the spray early, at the first appearance of the beetles, before they have opportunity to destroy the buds. Where only a few vines are concerned, the adults may be jarred off onto sheets, if the work is done early in the morning before the beetles

Fig. 369.—Larva of the Grape Flea-beetle. Enlarged and natural size. Original.

Fig. 370.—The Grape Flea-beetle. Adult, enlarged and natural size. Original.

become active. Cleaning up rubbish will help to reduce the numbers of overwintering adults.

FIG. 371.—Work of the Strawberry Flea-beetle. Original.

The Strawberry Flea-beetle

(*Haltica ignita* Illig.)

A shining, active beetle, one fifth of an inch long, appears in early summer on the leaves of strawberry and other plants. Its shape is rather oblong, and its color ranges from golden to greenish, or deep blue. Shortly afterward the larvæ may be found on the foliage, usually on the under leaves where they are concealed. They are almost black and one fourth of an inch long. The body surface is covered with low tubercles.

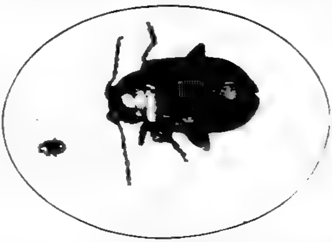

FIG. 372.—The Strawberry Flea-beetle. Enlarged and natural size. Original.

Pupation takes place in the soil. In the South there are two or three generations annually; in the North one.

The pest is easily checked by spraying or dusting with arsenate of lead or Paris green.

The Tent Caterpillar (*Malacosoma americana* Fab.)

In the spring leaves of apple, wild cherry, and other plants are stripped by this caterpillar. Its work is characterized by the formation of a conspicuous web or nest in the forks of smaller branches, the caterpillars spending part of their time on or in this nest and going

out from it to feed on the leaves. They do not form any webs on the leaves, but only the tent in the forks.

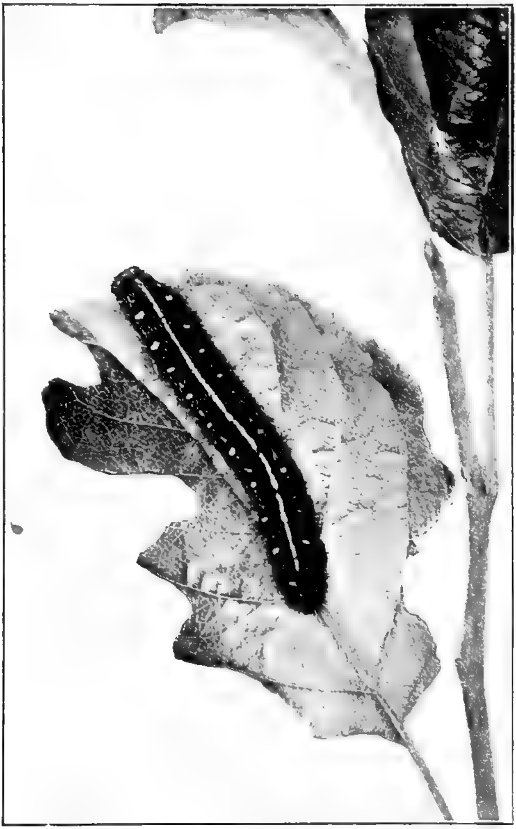

FIG. 373.—The Tent Caterpillar. Original.

The full-grown caterpillar is about two inches long. Its body is black, ornamented with a well-defined white line down the middle of its back, and with a row of blue spots along each side. The adult moth is dull reddish in color.

The eggs are laid in a compact mass, encircling a twig, and remain where placed until the following spring. The caterpillars hatch as soon as the foliage is out.

Nests and caterpillars may be destroyed by burning with a torch, selecting a time when the caterpillars are at rest on or in their web.

FIG. 374. — Nest of the Tent Caterpillar. Original.

FIG. 375. — Egg-mass of the Tent Caterpillar. Original.

FIG. 376. — Adult of the Tent Caterpillar. Original.

They will be found there when the weather is cloudy or stormy, or early in the morning before the sun is well up. Instead of burning, the nests may be sprayed with 25 per cent kerosene emulsion or with

pure kerosene, taking care not to get this on the surrounding foliage. Spraying the foliage with Paris green or arsenate of lead will easily poison the caterpillars.

Fig. 377. — The Forest Tent Caterpillar. Original.

The Forest Tent Caterpillar

(*Malacosoma disstria* Hbn.)

The common name of this species is misleading, for it does not construct a tent. It is, however, closely related to the tent caterpillar, and has acquired a similar name. While often a forest pest, it is apt to attack fruit tree foliage as well, and may strip the trees when abundant.

Fig. 378. — Egg-mass of the Forest Tent Caterpillar. Original.

The full-grown caterpillar is two inches long, dark in color, and has a row of conspicuous, diamond-shaped, white spots down the middle of its back. Eggs are laid in a compact ring around twigs, and covered with a shining varnish. The young caterpillars appear early in spring.

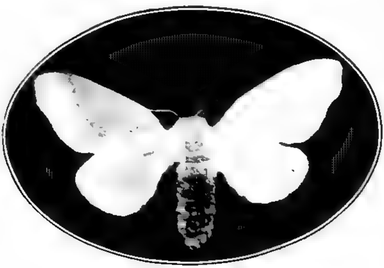

Fig. 379. — Adult of the Forest Tent Caterpillar. Original.

They have a habit of traveling back and forth up and down the trunk and limbs of a tree, and sometimes collect in masses.

On orchard trees they are readily controlled by poison sprays, preferably arsenate of lead.

The Yellow-necked Caterpillar (*Datana ministra* Dru.)

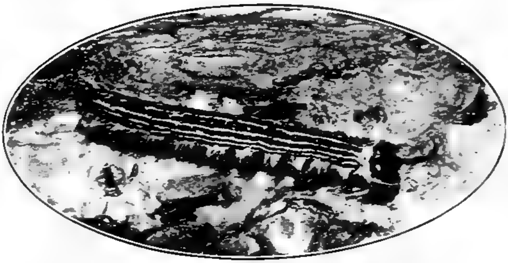

Fig. 380. — The Yellow-necked Caterpillar. Original.

In late summer yellow and black striped caterpillars feed on orchard foliage, working in colonies and stripping a single limb as they go. The mature caterpillar is nearly two inches long. Just back of the head is an orange ridge. When disturbed, the caterpillars raise both head and tail into the air, holding fast by the middle.

Fig. 381. — Adult of the Yellow-necked Caterpillar. Original.

The eggs are laid on the leaves in midsummer, by a brownish moth. Winter is passed as a pupa in the soil. There is one generation annually.

Removal of the colonies of caterpillars by cutting off the twig or limb is the usual procedure. They may easily be killed by spraying with Paris green or arsenate of lead. Where orchards are given a spraying with arsenicals the first of August this pest will not be in evidence.

The Red-humped Apple Caterpillar (*Schizura concinna* S. and A.)

Fig. 382. — The Red-humped Apple Caterpillar. Original.

This species has the same habits and life round as the preceding. It is abundant in late summer, and feeds in colonies. Like the other, it jerks its head and tail into the air when alarmed. The body of the caterpillar is spiny, and is marked with fine, narrow stripes of black and yellow. A short distance back of the head is a hump which is conspicuously red.

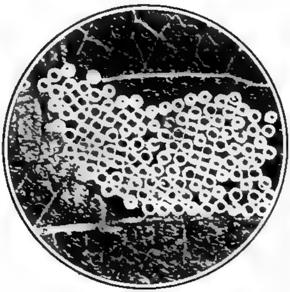

Fig. 383. — Eggs of the Red-humped Apple Caterpillar. Enlarged. Original.

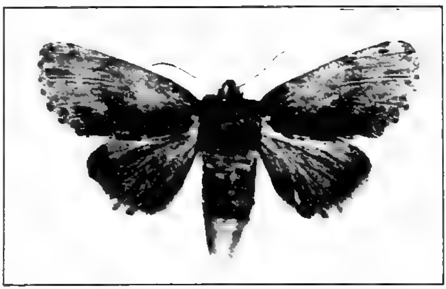

Fig. 384. — Adult of the Red-humped Apple Caterpillar. Slightly enlarged. Original.

Control is the same as for the preceding species. The two will be found on orchard foliage at about the same time of year.

Caterpillars of Hawk Moths

Large and conspicuous worms two or three inches long are often found on the foliage of grapes and Virginia creeper. They vary in markings, but usually have a prominent spine or a distinct hard tubercle at the hind end. They feed singly, have enormous appetites, and will easily strip parts of the vines bare of leaves.

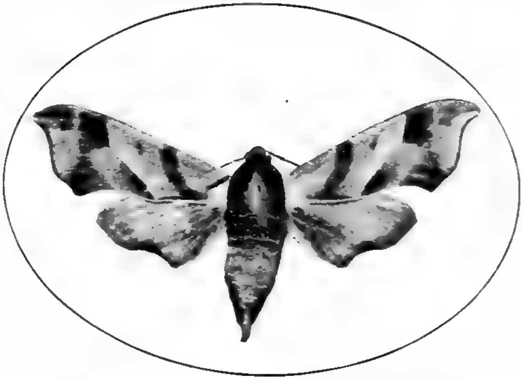

Fig. 385.—Adult of the Grapevine Hog Caterpillar. Original.

There are three or four species commonly to be seen. All are the immature stages of swift-flying, heavy-bodied moths, observed usually in the evening, poised over flowers, sipping the nectar, and known locally in some sections as "humming-bird moths." The pupal stage is passed in the soil. There is one generation annually.

Fig. 386.—The Achemon Sphinx. Slightly reduced. Original.

The Grapevine Hog Caterpillar (*Ampelophagus myron* Cram.) is two inches long, yellowish green, has two white stripes down the back and seven oblique stripes on each side, and seven pink or red spots down the middle of the back. There is a horn near the hind end. The Achemon Sphinx

(*Pholus achemon* Dru.) is three inches or more long when full grown, yellowish green in color to reddish brown, and has six conspicuous white dashes or spots down each side. The third segment back of

Fig. 387. — Larva of the Achemon Sphinx. Original.

the head is enlarged. At the hind end is a horn, changing to a round "eyespot" as the caterpillar nears maturity. Abbott's Sphinx (*Sphecodina abbottii* Swain) reaches a length of $2\frac{1}{2}$ inches, is light

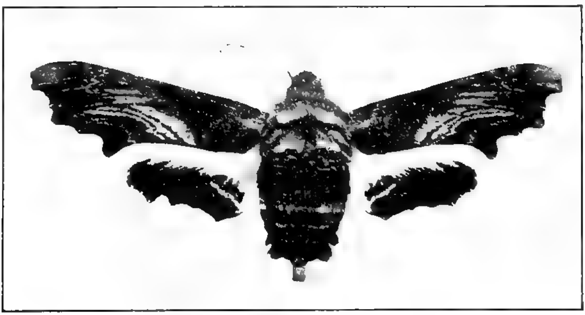

Fig. 388. — The Abbott's Sphinx. Original.

brown in color with darker streaks lengthwise of the body and black lines across each segment. At the hind end is a conspicuous, round black spot margined with yellow.

Since the larvæ are conspicuous and are not numerous, hand picking is feasible. Arsenical poisons, such as Paris green or arsenate of lead, may be used if desired.

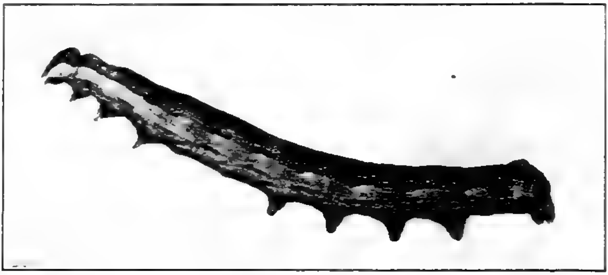

FIG. 389. — Larva of the Abbott's Sphinx. Original.

The Plum-tree Sphinx (*Sphinx drupiferarum* S. and A.)

Large, green caterpillars are sometimes in evidence on the foliage of plum trees, devouring the leaves. They are naked worms, two inches or more in length, the body marked on each side with seven diagonal dashes of narrow white bordered with purple. On the hind end is a conspicuous spine. The adults are strong-flying moths, seen hovering over flowers in the evening. The pupal stage is passed in the soil. There is one generation annually. Hand picking is the usual remedy, but arsenate of lead or Paris green may be used on the foliage if desired.

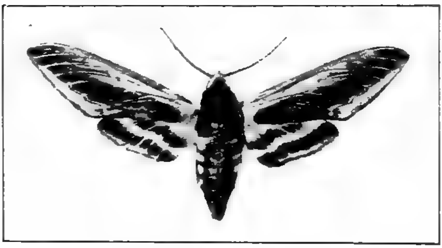

FIG. 390. — Adult Plum-tree Sphinx. Slightly reduced. Original.

The False Army-worm (*Calocampa nubera* Lint.)

In recent seasons, cranberry foliage has been severely injured by a large caterpillar, two inches long when full grown, dark green in color,

somewhat spotted with white, and with a greenish yellow head. The depredations take place in early summer. The moths are out in August and September.

Bogs attacked may be reflowed for 24 hours, when the worms are found at work, thus killing them or dislodging them from the vines. Arsenate of lead or Paris green may be used to advantage if applied while the worms are small.

The Smeared Dagger (*Acronycta* (*Apatela*) *oblinita* S. and A.)

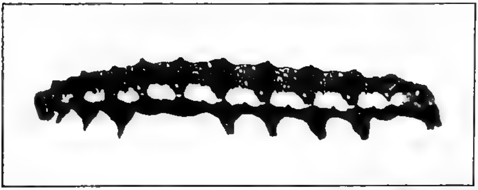

Fig. 391. — Larva of the Smeared Dagger. Original.

Conspicuous caterpillars, $1\frac{1}{4}$ inches long when full grown, feed on the foliage of strawberries and raspberries, and occasionally on clover. The body is velvety black. There is a band of red across the back on each segment, red tubercles and yellow spots along the back, and a yellow band along each side. There are two broods annually.

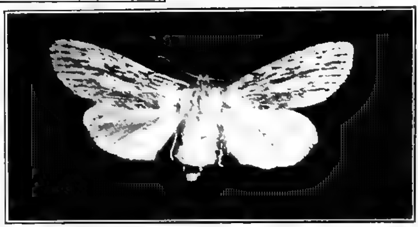

Fig. 392. — The Smeared Dagger. Original.

Control consists in prompt application of arsenate of lead or Paris green.

The Eight-spotted Forester (*Alypia octomaculata* Fab.)

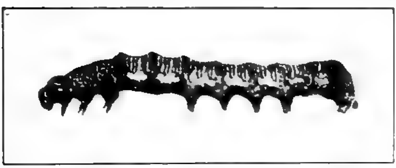

Fig. 393. — Larva of the Eight-spotted Forester. Original.

The foliage of grapes, and often of Virginia creeper, is eaten by conspicuous naked caterpillars, $1\frac{1}{2}$ inches long when mature. The head is bright orange. There is an orange band across each seg-

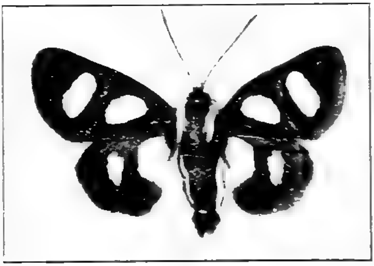

FIG. 394.—The Eight-spotted Forester. Slightly enlarged. Original.

ment, and on each side of the body is a wavy white longitudinal band, faint on the segments toward the head, but prominent toward the hind end. The adult moth is black, marked with eight large spots. The readiest means of control is to apply arsenate of lead or Paris green to the foliage.

The Grape-leaf Skeletonizer (*Harrisina americana* Guer-Men.)

Orderly rows of small, yellowish, black-spotted caterpillars feed on the surface of grape leaves, devouring the surface tissue, but leaving the veins untouched. Later, when more nearly full grown, the larvæ separate and work singly, eating all of the leaf except the main ribs.

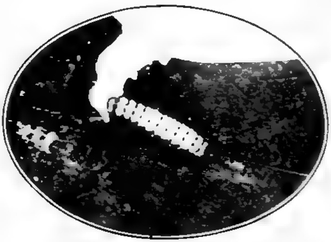

FIG. 395.—Larva of the Grape-leaf Skeletonizer. Original.

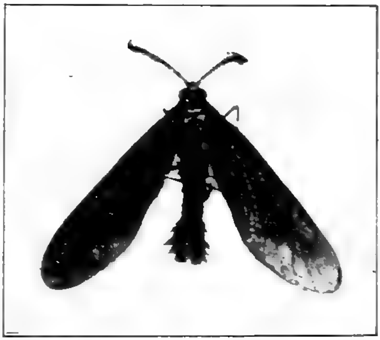

FIG. 396.—Adult of the Grape-leaf Skeletonizer, enlarged to three times natural size. Original.

The mature caterpillar is a half inch long.

The parent moth emerges in June, and lays eggs on the under side of grape leaves. Larvæ hatched from these eggs complete their growth in a month to six weeks, and a second generation of moths come out in July or August, followed by a second lot of caterpillars. The insect passes the winter in the pupal stage in dead leaves or rubbish.

When the caterpillars are feeding together, the simplest means of control is to remove the leaves on which they are at work. Later, when the larvæ have scattered, it is necessary to apply arsenate of lead or Paris green. If grapes are sprayed early with arsenicals, enough of the poison will adhere to check these insects when they begin feeding.

The Apple-leaf Skeletonizer (*Canarsia hammondi* Riley)

A small, brown caterpillar, not more than half an inch long when full grown, injures apple foliage by eating the surface of the leaves.

FIG. 397. — Work of the Apple-leaf Skeletonizer. Original.

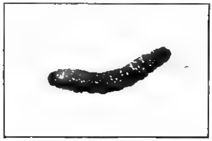

FIG. 398. — Larva of the Apple-leaf Skeletonizer. Enlarged. Original.

It begins work near the center of the leaf, and spins over itself a thin web. Frequently several of the worms will be found under a single web. The caterpillar is marked by four black dots just back of the head, two on the first segment and two on the second.

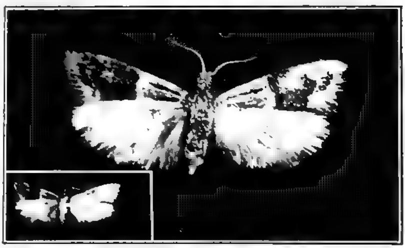

FIG. 399.— Adult of the Apple-Leaf Skeletonizer. Enlarged and natural size. Original.

The pupal stage is passed on the leaf. The adult is a grayish moth, expanding half an inch. There are two or three broods in a season.

The application of arsenate of lead or Paris green to the foliage will soon check the pest. It is necessary to

reach the terminal leaves, for the caterpillars are apt to feed in such locations.

The Palmer-worm (*Dichomeris ligulellus* Hbn. (*Ypsolophus pometellus* Harr.))

At occasional periods, separated by long intervals, a small striped caterpillar becomes numerous on apple and other trees, severely injuring the foliage and often eating irregular cavities in the surface of the young fruit. The full-grown worm is about a half inch long, has three narrow dark stripes down its back, and usually spins a few strands of silk over itself, sometimes thus bending over the edge of a leaf. The adult is a tiny moth. The best remedy is a prompt application of Paris green or arsenate of lead.

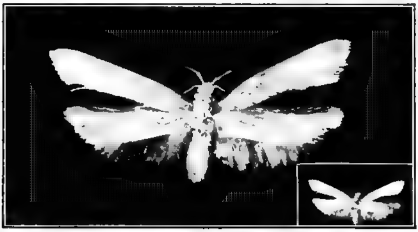

FIG. 400. — Adult of the Palmer-worm. Enlarged and natural size. Original.

The Apple-leaf Bucculatrix

(*Bucculatrix pomifoliella* Clem.)

Greenish yellow caterpillars, half an inch long when full grown, feed first in mines within the leaf tissues of apples, or related trees, and later on the surface, skeletonizing the leaf. The segments of the caterpillar's body are prominent and rounded.

FIG. 401. — Work of the Apple-leaf Bucculatrix. Original.

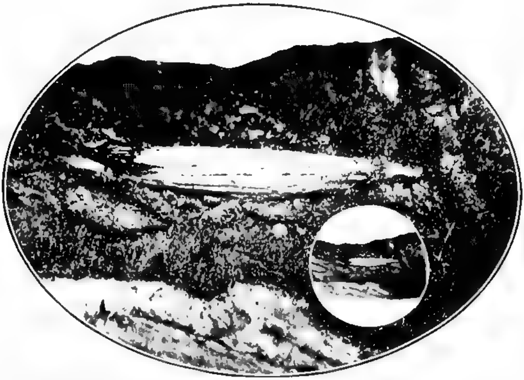

FIG. 402.—Cocoon of the Apple-leaf Bucculatrix. Enlarged and natural size. Original.

In the fall the larvæ migrate to twigs or branches and make small, whitish, ribbed cocoons, often somewhat conspicuous when occurring in large numbers. The tiny parent moth emerges from the cocoon the following spring.

FIG. 403.—Adult of the Apple-leaf Bucculatrix. Enlarged and natural size. Original.

The use of Paris green or arsenate of lead to poison the caterpillars when they begin feeding on the surface of the leaf is the easiest remedy, although a winter spraying with lime sulphur or 15 per cent kerosene emulsion will be likely to kill the overwintering form. The species is seldom a genuine pest.

The Spring Canker-worm (*Paleacrita vernata* Peck)

A small, naked measuring worm or inchworm attacks the foliage of apple trees in early spring. At first small holes are eaten in the leaves,

but later the entire leaf is destroyed, except the main veins. The worms are three fourths to one inch long, naked, dark green, and sometimes rather distinctly striped. They have a pair of prolegs or claspers on the hind end, a single pair a short distance forward of these, but no other legs from that point to the three pairs of true legs near the front end of the body. Thus, in moving, they arch the body so as to bring the hind end up near the front. This species may be distinguished from the similar fall canker-worm by the fact that the latter has an additional pair of rather small prolegs near the hind end.

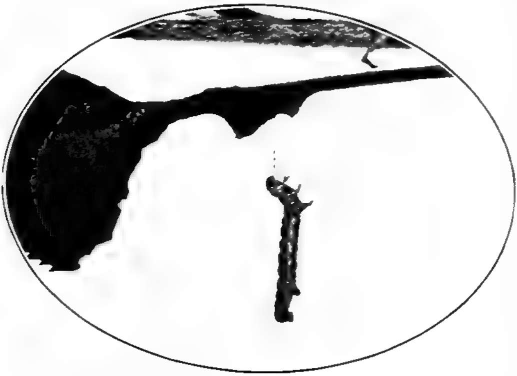

Fig. 404. — The Spring Canker-worm. Original.

Fig. 405. — Adult female of the Spring Canker-worm. Enlarged and natural size. Original.

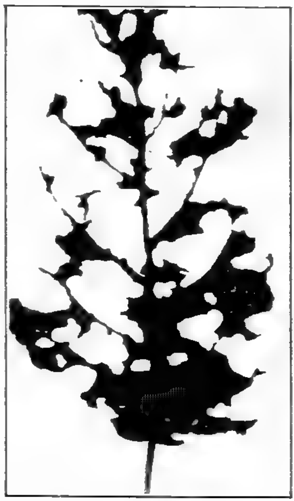

Fig. 406. — Work of Canker-worms. Original.

When full grown, the worms enter the ground, and remain there until the following spring. The adults come out several weeks before the apple is due to blossom. The female is wingless, crawls up the trunk, and lays her eggs. The male is winged. The eggs hatch after the apple leaves have unfolded.

Spraying with arsenicals, using rather heavy dosage, will kill the worms. Instead of this the trees may be banded six weeks before the apples are due to bloom, so as to prevent the females or the worms from reaching the upper parts of the tree. Orchards that are regularly sprayed with poisons, such as arsenate of lead or Paris green, will not suffer from this pest.

Fig. 407.—The Fall Canker-worm. Slightly enlarged. Original.

The Fall Canker-worm

(*Alsophila pometaria* Harr.)

This species is quite similar in characteristics to the spring canker-worm. The larva may readily be recognized from the fact that it has two pairs of prolegs near the hind end of the body just forward of the claspers located on the extreme hind end, whereas the spring canker-worm has only one pair. The injury wrought by the two species is identical. Either will strip the foliage from apple trees in early spring, when numerous.

The life round in this species is different from that of the spring canker-worm. The full-grown larva enters the soil to transform, but the adults emerge in the fall, instead of the spring. The female is wingless, and at once climbs the trunk and lays her eggs. These eggs remain over winter. They hatch in the spring, with the opening of the apple foliage.

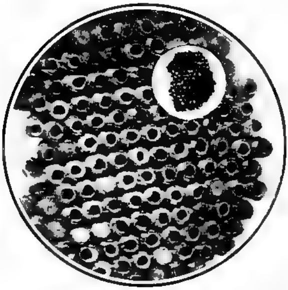

Fig. 408.— Eggs of the Fall Canker-worm. Enlarged and natural size. Original.

Spraying with arsenical poisons will control this species. If it is desired to control the pest by banding, it will be necessary to apply bands in the fall, so as to prevent the females from crawling up to the higher parts of the tree, and to renew the bands in the spring to prevent the young worms from ascending. The females, if stopped in the fall by bands, will lay eggs below the obstructions, and thus further banding at the hatching season in the spring is essential.

Fig. 409. — The Currant Spanworm. Slightly enlarged. Original.

The Currant Spanworm

(*Cymatophora ribearia* Fitch)

This worm is one of the loopers or measuring worms. It is a little over an inch long when mature, is light yellowish or cream colored, and dotted with black. The worms appear in early spring from eggs laid on the stems the previous summer by the parent moth. When they are very abundant, the foliage is destroyed by them.

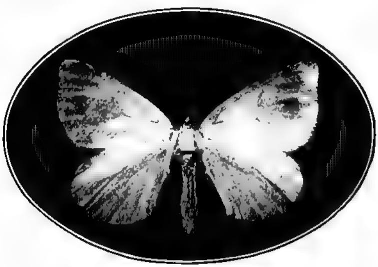

Fig. 410.—Adult of the Currant Spanworm. Original.

Spraying with arsenical poisons is a ready remedy. Usually the currants are not ripe when the worms appear, and therefore poison sprays may be used safely.

The Cranberry Spanworm (*Cleora pampinaria* Guen.)

The leaves of cranberry, asparagus, cotton, strawberry, apple, pear, clover, and others are sometimes eaten by a brownish or olive spanworm, $1\frac{1}{4}$ inches long when mature. Its body is streaked and mottled with lighter and darker shades. On the back, about one third of the way to the rear of the head, are two low black tubercles, and near the hind end are two more. There are two pairs of fleshy false legs near the hind end, and three pairs of true legs close to the front end. The worms have a habit of resting motionless, holding fast to a stem by the hind legs, the body projecting at an angle.

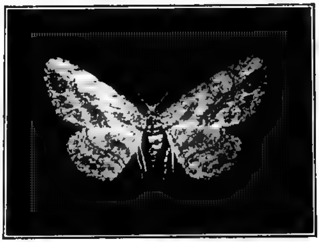

Fig. 411.—Adult of the Cranberry Spanworm. Original.

The adult is a gray moth marked with many spots and zigzag lines of black and brown. There are two generations annually, larvæ appearing in late June and again in August.

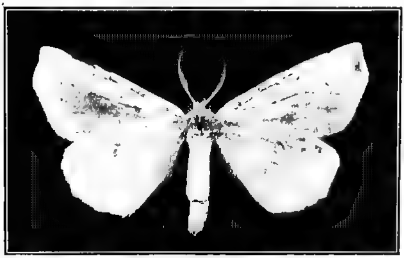

Fig. 412.—Adult of the Elm Spanworm. Original.

Dusting or spraying with arsenate of lead or Paris green will poison the worms.

The Elm Spanworm
(*Ennomos subsignarius* Hbn.)

In June the larvæ of this moth may be found on the foliage of a great variety of trees, including apple, pear, or other fruits as well as forest trees. Usually they are brown, but sometimes green, look much like a twig, and have three low tubercles on the back, one near the hind

end, another a third of the way toward the head end, and another two thirds of the way toward the head. They have no feet along the middle part of the body, and move with a looping gait. The adult is a white moth, expanding about $1\frac{1}{2}$ inches. Eggs are laid in July, in masses on the twigs, and hatch the following summer.

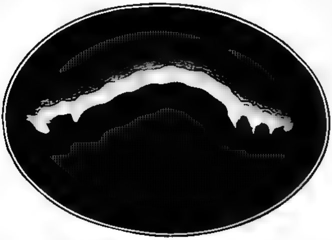

FIG. 413. — Larva of the Lime-tree Winter Moth. Original.

On orchard trees the best measure of control is an application of arsenate of lead or Paris green.

The Lime-tree Winter Moth

(*Erannis tiliaria* Harr.)

The larva of this species sometimes strips the foliage of apple trees. It is a spanworm or "measuring worm," $1\frac{1}{4}$ inches long when full grown, the body yellowish above with several fine black lines down its back, the under side lighter.

FIG. 414. — The Lime-tree Winter Moth. Original.

The adult moths usually emerge in the fall, but occasionally not until spring. The male is winged, but the female is spiderlike and wingless. The caterpillars are at work in the early weeks of the growing season. Pupation takes place in the ground.

In its appearance and habits this species resembles the canker-worms. The remedies recommended for the latter will apply to this pest.

The Chain Spotted Geometer (*Cingilia catenaria* Dru.)

Characteristic, slender measuring worms, $1\frac{1}{2}$ inches long when full grown, feed on the foliage of various bush fruits. The caterpillar

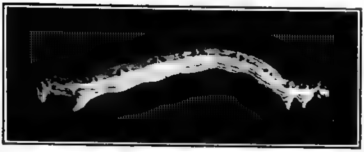

FIG. 415. — Larva of the Chain Spotted Geometer. Original.

is cylindrical, light yellow, marked with two fine, brown lines on the back and two on the sides, and distinctly marked with two black dots on each segment.

Pupation takes place in a delicate, lace-like cocoon among the leaves. The adult moths are numerous in late summer.

The worms are easily poisoned by applying arsenate of lead or Paris green to the foliage.

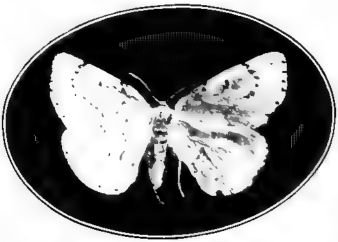

FIG. 416. — Adult of the Chain Spotted Geometer. Original.

The Imported Currant Worm

(*Pteronus ribesii* Scop.)

FIG. 417. — The Imported Currant Worm. Work and larvæ. Original.

Currants and gooseberries are subject to periodical stripping by this worm. Throughout most of its existence the larva is greenish in color, marked with numerous black dots, but just before transforming it is clear green without any dots. When full grown, its length is three fourths of an inch.

FIG. 418.—Cocoons of the Imported Currant Worm. Original.

The pupal stage is passed in little cells in the soil. There are two generations, one lot of worms appearing in early summer and the second brood five or six weeks later. Hibernation takes place in the pupal stage. The adult is a sawfly.

Until currants are ripe the best remedy is an application of Paris green and lime. If the spraying is done early, arsenate of lead may be used. When the fruit is coloring, use hellebore.

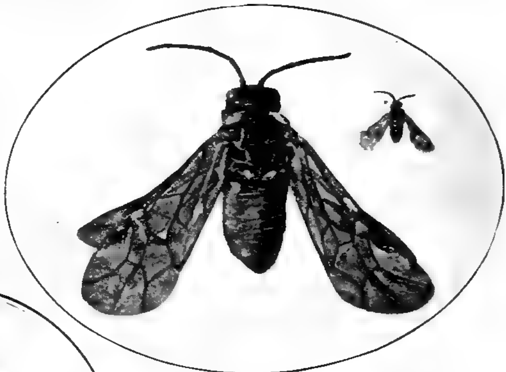

FIG. 419.—Adult of the Imported Currant Worm. Enlarged and natural size. Original.

The Native Currant Worm (*Diphadnus appendiculatus* Hartig) causes similar defoliation. The larva is half an inch long, and light green, without black spots. There are two generations. The adult is a sawfly. The measures of control are the same as for the imported currant worm. Paris green may be used safely until the fruit is half grown.

FIG. 420.—Adult of the Native Currant Worm. Enlarged and natural size. Original.

The Raspberry Sawfly (*Monophadnoides rubi* Harr.)

Greenish, spiny worms eat the foliage of raspberry and blackberry, stripping the bushes and leaving only the main leaf veins. The full-grown larva is three fourths of an inch long and covered with short

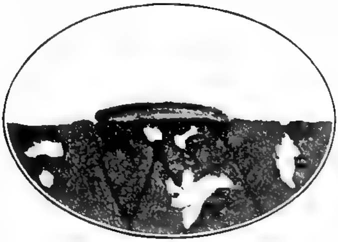

Fig. 421. — Larva of the Raspberry Sawfly. Original.

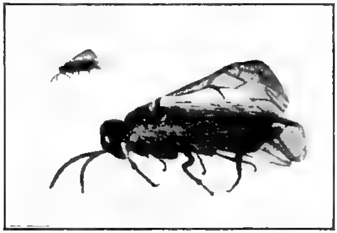

Fig. 422. — The Raspberry Sawfly. Enlarged and natural size. Original.

spines, which are dark on its back but light on its sides. When mature, the worms enter the ground, and remain there until the following spring, when the transformation to the adult sawfly takes place.

Paris green or arsenate of lead may be used to poison the worms until the fruit is set. After that use hellebore.

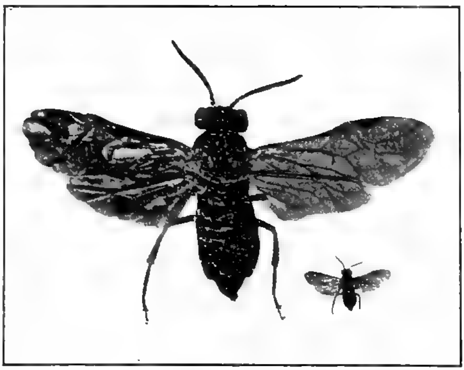

Fig. 423. — The Grape Sawfly. Enlarged and natural size. Original.

The Grape Sawfly

(*Selandria vitis* Say)

Greenish or yellowish slugs, their bodies dotted with black, feed in groups on the leaves of grapes, usually on the under side of the leaf. The adult is a sawfly. There are two broods annually.

An application of arsenate of lead or Paris green is the best control measure until the fruit is well colored.

The Strawberry Sawfly (*Empria* (*Harpiphorus*) *maculata* Nort.)

About the time that strawberries begin blooming, the leaves are eaten by sluglike worms, half an inch long, yellowish in color, with a pale stripe down the back. When not feeding, the slugs often rest on

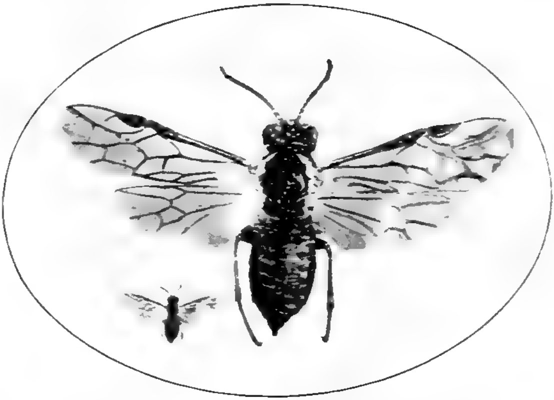

FIG. 424. — The Strawberry Sawfly. Enlarged and natural size. Original.

the under surface of the leaf, coiled in a sort of spiral. The adults are small, four-winged insects. Winter is passed in the ground. There is one brood each year.

The best means of control is an early application of arsenical poisons. If ripe strawberries are already on the vines when injury is noted, hellebore may be used.

The Pear-slug (*Caliroa* (*Eriocampoides*) *cerasi* Linn.)

Small, dark green, slimy slugs eat the surface of the leaves of pear, cherry, and plum, gnawing off the epidermis and leaving the veins and lower surface. The tissues where they have been at work turn brown,

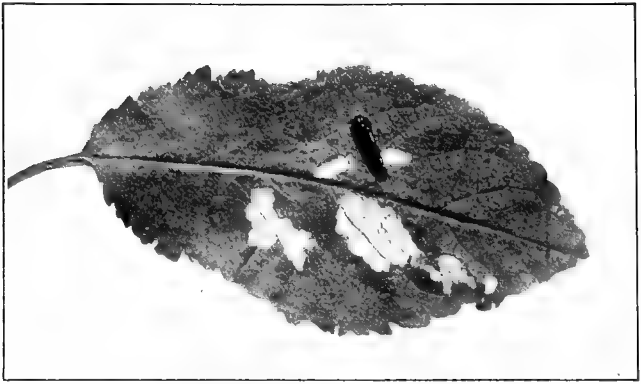

Fig. 425. — Work and larva of the Pear-slug. Original.

and if the slugs are numerous, the entire foliage of the tree may look scorched and drop off. When nearly full grown, the larvæ lose their slimy coating with the last molt, and are then a clear yellow in color.

There are two or three generations in a season. The slugs are apt to be more numerous in the middle or latter part of summer. The adult is a sawfly. Eggs are laid within the tissues of the leaf.

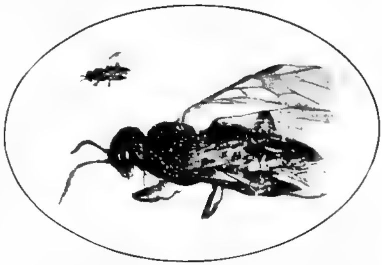

Fig. 426. — Adult of the Pear-slug. Enlarged and natural size. Original.

Ordinarily the simplest means of control is to apply Paris green or arsenate of lead to the foliage. The slugs are easily killed.

The Peach and Plum Slug (*Caliroa amygdalina* Rohwer)

The work of this insect is similar to that of the common pear-slug. The species is found in the Gulf states. There are half a dozen or more generations each season, and injury is most severe toward the end of summer. Spraying with an arsenical poison is the readiest remedy.

The Gypsy Moth (*Porthetria dispar* Linn.)

This notorious European pest has now become established in the New England states, where it is doing immense damage, defoliating forest, shade, and fruit trees. Evergreens are freely attacked after the caterpillars are half grown.

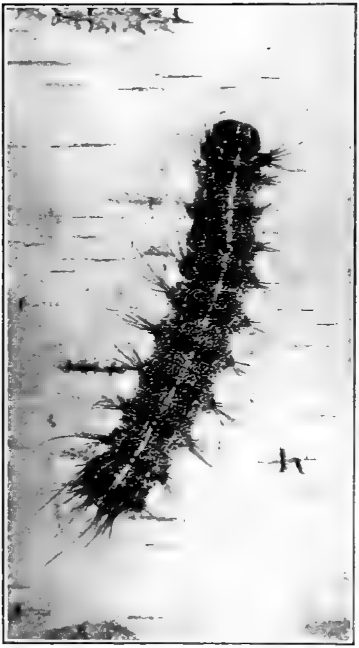

Fig. 427. — Larva of the Gypsy Moth. Original.

The full-grown gypsy caterpillar is $2\frac{1}{2}$ inches long, hairy, and dark or black in general color. Beginning just behind the head there is a double row of five dark blue spots down the back, followed by a double row of six dark red spots, the last pair of the latter just above the hind end. After they are three fourths grown the caterpillars tend to feed only at night, coming down the trunks of the trees and hiding or resting in masses during daylight.

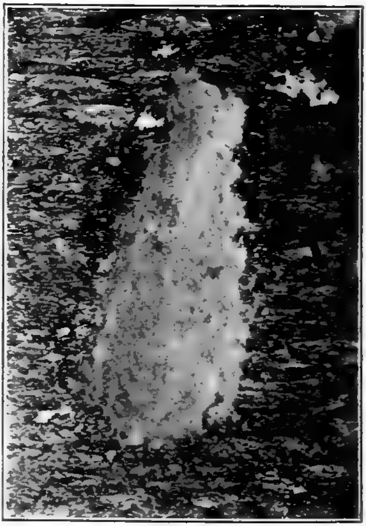

Fig. 428. — Egg-mass of the Gypsy Moth on bark. Original.

Pupation takes place in a flimsy cocoon, on the trunk or

near by, and the adult moths are out in July and August. The female is light grayish, heavy bodied, and has a wing expanse of two inches, but cannot fly. The male is much smaller, brown in general color, and flies readily. Eggs are laid in masses, and are covered with yellowish hairs from the body of the female. Egg masses occur on the trunks of trees, the under side of branches, or on any permanent object near at hand. The egg stage lasts until the following May, when the young caterpillars hatch and at once begin feeding.

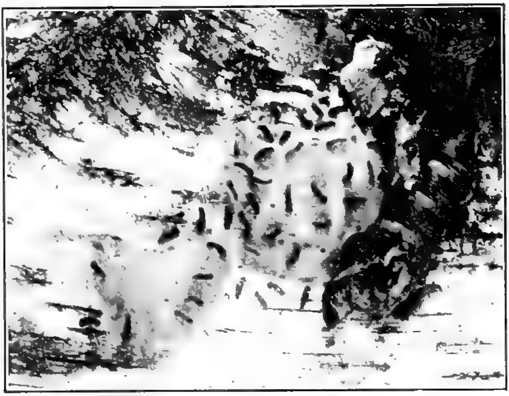

Fig. 429.—Newly hatched larvæ of the Gypsy Moth on egg-mass; and empty pupal shell. Original.

Large sums have been spent by federal, state, and town authorities to prevent the spread of this pest, reduce its ravages, and introduce its natural enemies.

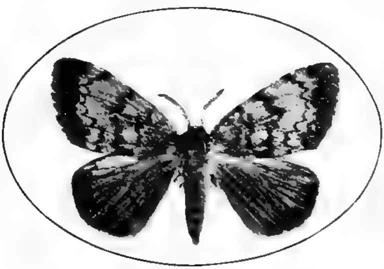

Fig. 430.—The Gypsy Moth. Adult male. Original.

The egg masses may be painted with creosote at any time between September and the following April. This will penetrate and kill the eggs.

The larvæ may be poisoned by spraying with arsenate of lead, using 5 to 8 pounds to 50 gallons of water, and applying early while the larvæ are still small. Tall trees may be banded with burlap, so as to provide a place where the caterpillars will hide by day and where they may be killed by mechanical means.

FIG. 431. — The Gypsy Moth. Adult female. Original.

Evergreens may be protected by banding the trunks with tanglefoot to prevent larvæ from crawling up into them after getting a start on deciduous growth near by. The same plan is useful to prevent injury to fruit or shade trees that have been properly cared for but are threatened by larvæ coming from egg masses in stone walls or on neglected growth close at hand.

FIG. 432. — Winter nest of the Browntail Moth. Original.

In woods of mixed growth it is advisable to remove all hard wood, leaving only a stand of pure evergreen, since the larvæ cannot live on evergreens until half grown.

The Browntail Moth

(*Euproctis chrysorrhœa* Linn.)

Throughout winter the small, compact nests of this insect are conspicuous on the tips of twigs of many species of orchard and shade trees and shrubs. A typical nest usually includes two or three

leaves woven up tightly in silk, and attached to the twig by a tough strand of silk, which often follows the petiole of a leaf. Evergreens are not attacked by this species.

Within the nest are several hundred very small caterpillars. Before foliage starts in the spring they come out and wander over the twigs

FIG. 433. — Larva of the Browntail Moth. Original.

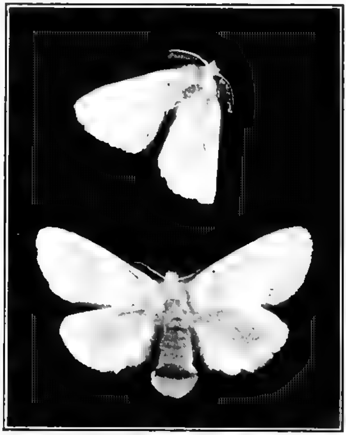

FIG. 434. — Adult Browntail Moths. Male above, female below. Original.

near the nest. When growth starts, they begin at once feeding on the foliage, often eating the leaves as fast as they unfold.

The mature caterpillar is an inch and a quarter long, brownish in general color, marked with a row of oblique white dashes down each side of its back, and with two orange spots near the hind end, one behind the other.

Pupation takes place among the leaves. The adults emerge in July. Their wings are pure white, and the body of the female bears a tuft of brown hairs at the end of the abdomen. The moths fly at night and often are seen in large numbers around lights. Eggs are laid on the leaves and hatch early in August. The young caterpillars skeleton-

ize leaves near by, giving the foliage a brown appearance. After a few weeks they make their winter nest and retire to it, remaining therein until the following spring.

In addition to the damage done by the caterpillars there is an annoying and sometimes serious poisoning of human beings by barbed hairs borne by the caterpillars. These hairs often are carried by the wind.

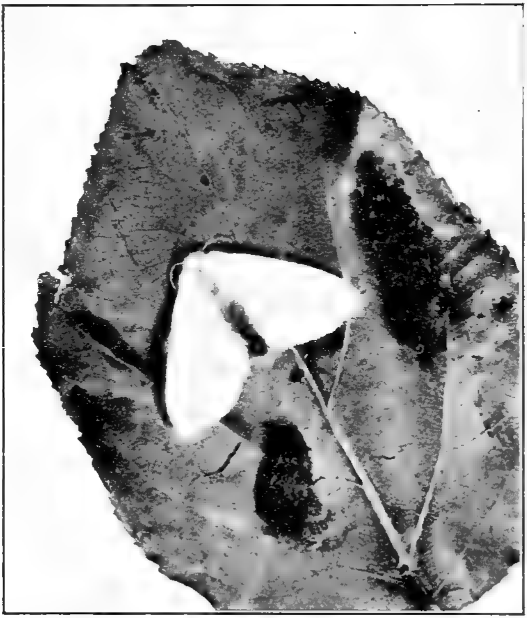

FIG. 435.—Egg-masses and adult female of the Browntail Moth. Original.

The ordinary means of control is the removal and burning of the winter nests. On fruit trees it is a better plan to spray with arsenical poisons the first week in August, at the time when the caterpillars are just hatching from the egg. They are not resistant to poison when small, and a moderate dose will kill them. Spraying in the spring is not satisfactory.

The Tussock Moths

Three species of caterpillars of striking appearance, the larval stages of tussock moths, infest the foliage of orchard and forest trees. Of

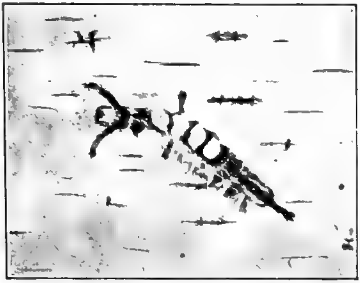

FIG. 436. — Larva of the Rusty Tussock Moth. Original.

FIG. 437. — Egg-mass of the White Marked Tussock Moth on cocoon. Original.

these the White Marked Tussock Moth (*Hemerocampa leucostigma* S. and A.) is in many sections the most common, while in others the Rusty Tussock Moth (*Hemerocampa antiqua* Linn.) or the Definite Marked Tussock Moth (*Hemerocampa definita* Pack.) may be the one most in evidence.

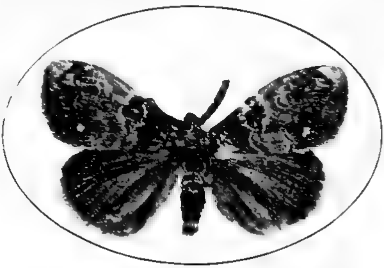

FIG. 438. — The White Marked Tussock Moth. Adult male. Original.

FIG. 439. — The Rusty Tussock Moth. Adult female. Original.

The caterpillar of the white marked tussock moth is hairy, $1\frac{1}{4}$ to $1\frac{1}{2}$ inches long, yellow, striped with black. Its head is bright red. There are four tufts of white hair on its back, a pencil of black hair projecting

forward on either side of its head, and a similar single pencil projecting back from the hind end. The caterpillars of the other two species are somewhat similar in appearance, though not so brightly colored.

FIG. 440. — Egg-mass of the Rusty Tussock Moth. Original.

The eggs of the first species are laid in a mass of frothy, white substance, on top of the cocoon of the female, on the bark of trunk or limb. The eggs of the others are not covered with froth. The adult females are wingless, looking somewhat like gray spiders. They emerge and lay their eggs in late summer.

The simplest means of control is to spray with arsenical poison, either Paris green or arsenate of lead. Egg masses may be destroyed when found by painting them with creosote. Sometimes trees are banded to prevent the insect from invading them from near-by uncared-for premises.

FIG. 441. — The Fall Webworm. Original.

The Fall Webworm (*Hyphantria cunea* Dru.)

Colonies of hairy caterpillars feed in company on the foliage of orchard or forest trees, building a web around the terminal leaves. As the green leaves within their nest are devoured, fresh foliage is drawn in and the nest enlarged, until it becomes decidedly conspicuous. Several different

webs may be made in succession by the same colony. The caterpillars have a dark body, covered with long, whitish hairs. The work is entirely distinct from that of the tent caterpillar, which builds its nest in the forks of branches and does not include any foliage in it.

When full grown, the caterpillars disperse, hide away, and spin up cocoons, from which the adult moths emerge the following summer. In the South there are two generations.

Fig. 442. — Work of the Leaf Crumpler. Original.

Trees may be sprayed with arsenate of lead or Paris green, and the caterpillars thus killed when they extend their webs over new and poisoned foliage. Or the nests may be cut off when first observed, and destroyed, along with the caterpillars in them.

The Leaf Crumpler

(*Mineola indiginella* Zell.)

In winter dark little twisted cases of silk mixed with bits of leaves may be seen attached to twigs of apple trees. From these, brownish red caterpillars, one fourth of an inch long, come out in

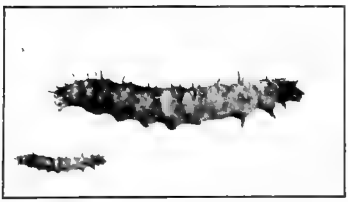

Fig. 443. — Larva of the Leaf Crumpler. Enlarged and natural size. Original.

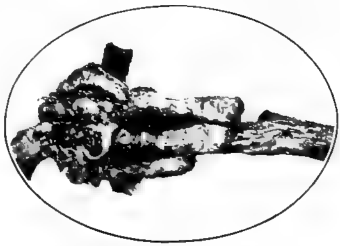

Fig. 444. — Larval cases of the Leaf Crumpler on twig. Original.

early spring and attack the tender foliage, drawing the leaves of a cluster more or less together with silk. Before long the dried bunches of dead leaves are conspicuous.

The adult is a moth, expanding about three fourths of an inch, its wings gray, with darker and lighter markings. Eggs are laid in midsummer, and the young larvæ feed for a time, later moving to the twigs where they construct their winter shelter.

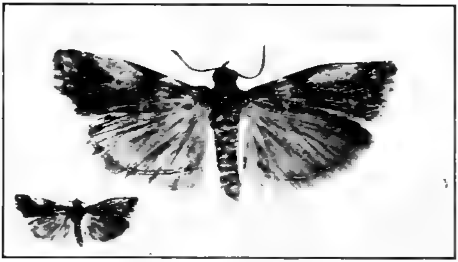

Fig. 445. — Adult of the Leaf Crumpler. Enlarged and natural size. Original.

Early, prompt spraying in the spring with arsenate of lead or Paris green will kill the caterpillars, but the treatment must be given before the work is well advanced. If orchard trees are regularly sprayed, they will seldom suffer damage from this pest, because the poison adhering to the foliage will kill the young larvæ when they begin work in midsummer, before they retire to their winter homes.

The Bud-moth (*Spilonota* (*Tmetocera*) *ocellana* Schiff.)

The opening buds of apple, pear, and sometimes cherry, peach, or plum are attacked by small whitish caterpillars, one fourth of an inch long or less, with dark brown heads. As the young leaves expand, the caterpillars bind them to-

Fig. 446. — Work of the Bud-moth. Original.

gether with silk, feeding inside, so that small, dead, brown clusters are to be seen here and there. When full grown, the larvæ are brownish, and three quarters of an inch long.

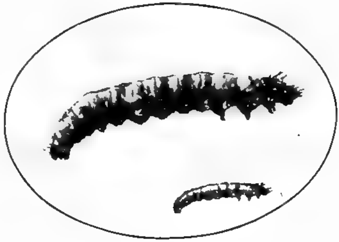

FIG. 447. — Larva of the Bud-moth. Enlarged and natural size. Original.

The caterpillars change to pupæ within the webbed leaves, and later the small gray and brown moths appear and lay eggs on the underside of leaves. The tiny worms which hatch from these feed for a few weeks and then migrate to twigs and make silk cases in which they pass the winter.

Spraying with arsenicals is effective if done very early when the buds are just expanding, and repeated as soon as the leaves are fairly out. Regular seasonal sprayings will control this species through poisoning the larvæ when they first hatch from the eggs in midsummer. For this reason they are not apt to be seen in well-cared-for orchards.

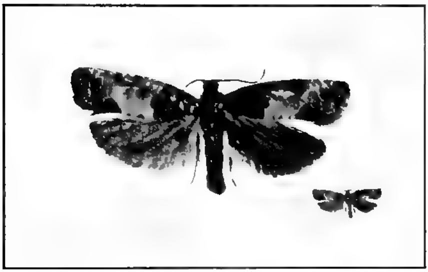

FIG. 448. — The Bud-moth. Enlarged and natural size. Original.

The Blackhead Cranberry Worm (*Rhopobota* (*Eudemis*) *vacciniana* Pack.)

Small, velvety green caterpillars, with shining black heads, draw together the tip leaves on uprights and feed within. The pest is commonly known as the "fire worm" because of the scorched appearance of a badly infested bog. There are two broods annually. The species overwinters as an egg attached to the under side of the leaf.

Where sufficient water is available, it is an effective plan to reflow for two or three days when the worms are coming down out of the uprights and pupating. If this is not feasible, the only satisfactory

remedy is to apply arsenicals early to poison the worms. The second brood, if serious, can be controlled only by applying arsenical poisons.

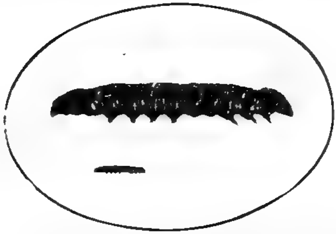

FIG. 449.—The Blackhead Cranberry Worm. Enlarged and natural size. Original.

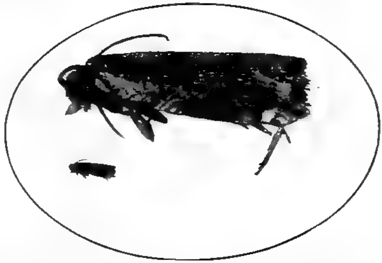

FIG. 450.—Adult of the Blackhead Cranberry Worm. Enlarged and natural size. Original.

The Yellowhead Cranberry Worm (*Peronea* (*Acleris*) *minuta* Rob.)

The larva of this species is quite similar in appearance to the preceding, but has a yellow head. It works in the same manner, webbing up the tips and destroying or killing the foliage within.

The winter is passed as an adult moth. The most practical means of control is to hold the water in the spring so as to force these adults to

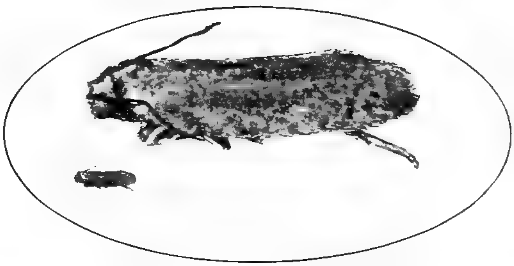

FIG. 451.—Adult of the Yellowhead Cranberry Worm. Enlarged and natural size. Original.

lay their eggs elsewhere. On infested bogs reflowing for 48 hours will kill the worms. There are three broods annually. Spraying or dusting with arsenical poisons is effective, if done early.

The Grape Plume Moth (*Oxyptilus periscelidactylus* Fitch)

Small, green or yellow larvæ, half an inch long when mature, web together the younger leaves of grapes and feed on the foliage within.

Fig. 452. — Work and empty pupal skin of the Grape Plume Moth. Original.

They are seldom numerous enough to be a pest. The adult is a delicate, buff-colored moth, with narrow, feathery wings. The usual and

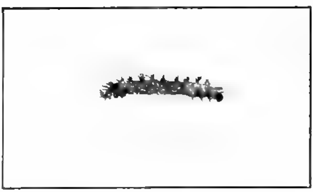

Fig. 453. — Larva of the Grape Plume Moth. Slightly enlarged. Original.

Fig. 454. — The Grape Plume Moth. Enlarged to twice natural size. Original.

easiest means of control is to pick off and destroy the webbed-up clusters of leaves.

The Oblique Banded Leaf-roller (*Archips rosaceana* Harr.)

Active, light green or rosy caterpillars, three quarters of an inch long, with a darker stripe down the back, roll up the leaves, fasten them with silk, and feed within. They infest apple and other fruit trees, raspberries, roses, and strawberries, and often are destructive to flowering plants in greenhouses. Pupation takes place within the folded leaves. The adult is a smooth, brownish moth. See page 188.

Fig. 455.—Work of the Fruit-tree Leaf-roller. Original.

Control is often difficult, but a prompt, thorough use of Paris green or arsenate of lead will check the pest. Hand picking is sometimes feasible.

The Fruit-tree Leaf-roller

(*Archips* (*Cacœcia*) *argyrospila* Walk.)

The young leaves and fruit of orchard trees and bush fruits are attacked by yellowish larvæ, which spin threads wherever they go, drawing leaves somewhat together. The full-grown worm is about an inch long, has a black head, and has a few short hairs scattered over its body. It is active when disturbed.

Fig. 456.—Adults of the Fruit-tree Leaf-roller. Original.

The pest appears very early in spring, when the buds are first unfolding. It hatches from eggs laid in flat masses on the bark. There is one generation annually.

Early spraying with arsenate of lead or Paris green at the time that the buds are opening, and again when the blossoms have fallen, is the means of control.

The Grape Leaf-folder (*Desmia funeralis* Hbn.)

Leaves of grape are folded with their upper surfaces together by a small, active, greenish worm, which feeds inside. The worm is an inch long when full grown, has a brown head, and a brown spot on each side of the first two segments. Transformation takes place within the folded leaf.

Fig. 457. — Work and pupa of the Grape Leaf-folder. Slightly enlarged. Original.

The adult is a small moth with black wings spotted with white. There are two broods in the North, three in the South. Winter is passed as a pupa in the folded leaf on the ground.

To control, destroy or plow under the fallen leaves. Or spray very early in summer with Paris green or arsenate of lead so as to poison the first lot of caterpillars when they have just hatched and before they fold the leaves.

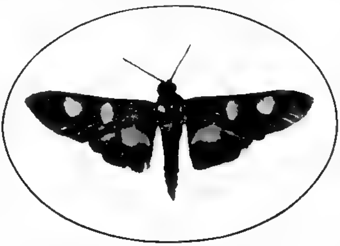

Fig. 458. — Adult of the Grape Leaf-folder. Original.

The Strawberry Leaf-roller

(*Ancylis comptana* Fröhl.)

A tiny worm, one third of an inch long, brown or often green in color, folds the leaves of strawberry, or sometimes blackberry or raspberry, and feeds within. As the larva eats off the inclosed leaf surface the leaf turns brown, and when the pests are numerous, whole beds of plants will look as if scorched.

Two broods occur in the North and three in the South. The later

broods are found on blackberry or raspberry, rather than strawberry. On blackberry leaves the work is similar to that on strawberry leaves, but on raspberry the larvæ tend rather to web up a terminal cluster of leaves. Hibernation takes place as larva or pupa within a folded leaf. The adult is a tiny brownish moth, expanding a little less than half an inch.

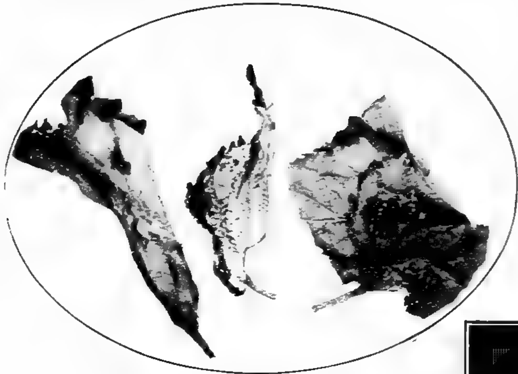

FIG. 459. — Work of the Strawberry Leaf-roller. Original.

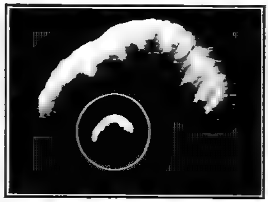

FIG. 460. — Larva of the Strawberry Leaf-roller. Enlarged and natural size. Original.

FIG. 461. — Adult of the Strawberry Leaf-roller. Enlarged and natural size. Original.

Since the larvæ feed for a short time exposed on the upper surface of the leaf before drawing it together, an early application of Paris green or arsenate of lead will check the pest. This application must be made early, and usually must be repeated, because new leaves are being put out

by the plant. In the South it has been found feasible to cut over strawberry beds in midsummer and burn them. It is said that the plants are not permanently injured by this treatment.

The Apple Leaf-sewer (*Ancylis nubeculana* Clem.)

FIG. 462.—Work of the Apple Leaf-sewer. Original.

The leaves of apple or other fruit trees are folded along the midrib, so that their upper surfaces are brought together, and a small, active, greenish caterpillar, not more than a half inch long, feeds within. The adult is a brown and white moth. Winter is passed within the folded leaves on the ground.

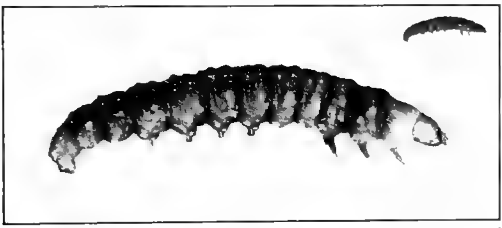

FIG. 463.—Larva of the Apple Leaf-sewer. Enlarged and natural size. Original.

If the pest is numerous, rake up and burn the leaves in winter. Early applications of arsenate of lead or Paris green, as

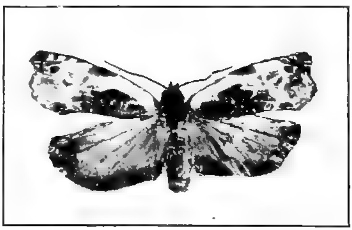

FIG. 464.—Adult of the Apple Leaf-sewer. Enlarged to twice natural size. Original.

called for in regular orchard spraying, will poison the larvæ before they fold the leaf.

The Lesser Apple Leaf-folder (*Peronea minuta* Rob.)

A greenish yellow, naked worm, a half inch long, with a yellow head, folds together the tender terminal leaves on apple trees, especially in nurseries. When attacking larger leaves, it often bends over and fastens only a small part of the leaf near the margin. There are three broods annually, the larvæ being at work first soon after the leaves are well out, again in June, and again in August. See page 300.

To control, apply arsenate of lead in the spring as soon as the leaves are expanded, and repeat for the later broods.

Fig. 465. — Adult of the Cigar Case-bearer. Enlarged and natural size. Original.

The Cigar Case-bearer (*Coleophora fletcherella* Fern.)

Areas in the leaves of apple, pear, or quince are mined and turned down by a very small caterpillar that carries with him a little cylindrical case made of a tiny section of a leaf, the hind part of his body protected by this case. The caterpillar completes its growth in June, migrates to a branch, to which it attaches its case, and transforms. The adult moths fly in July and lay eggs on the leaves. The young caterpillar first mines in the leaf tissue, and later constructs a very small,

Fig. 466. — Larval cases of the Cigar Case-bearer. Original.

short case, which it carries to a twig and in which it spends the winter.

The remedy is an application of arsenate of lead or Paris green as soon as the caterpillars are seen feeding.

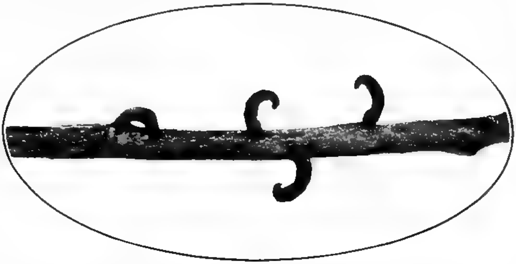

FIG. 467. — Larval cases of the Pistol Case-bearer. Enlarged. Original.

The Pistol Case-bearer (*Coleophora malivorella* Riley) has a similar life history and does about the same injury. It is distinguished from the above by the shape of the larval case, which in this species is slender, somewhat tapering, and distinctly curved.

FIG. 468. — Larval case of the Bag-worm. Original.

The Bag-worm

(*Thyridopteryx ephemeræformis* Steph.)

This curious larva makes a bag out of silk and pieces of leaves as a protection to its body. The female is wingless and never leaves the bag. The male is a small, clear-winged moth. Eggs are deposited by the female within the bag, and remain there until the following spring.

FIG. 469. — Adult male of the Bag-worm. Slightly enlarged. Original.

Removal of the bags in winter will put a

stop to the insect. Or the foliage may be sprayed with arsenate of lead as soon as the leaves are out.

The Pear-leaf Blister-mite (*Eriophyes pyri* Pgst.)

The leaves of apple and pear often are infested with a species of mite that burrows into the tissues of the leaf, causing a characteristic discoloration and swelling. Spots show in the upper leaf surface, at

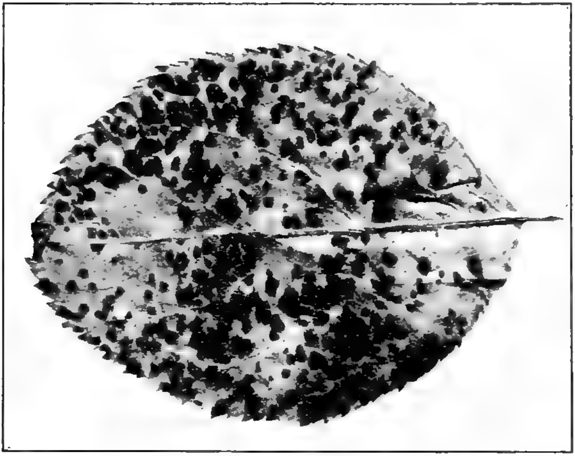

Fig. 470. — Work of the Pear-leaf Blister-mite. Original.

first reddish, but later turning brown. At each spot the leaf is somewhat thickened and its surface is slightly raised. Sometimes the fruit also is attacked and distorted.

The mites themselves are very small. They hibernate under bud scales, migrating to the leaves as soon as the latter unfold, entering the tissue from the under side and feeding within. From time to time individuals come out and move to new places, starting additional colonies and causing a continual increase in the number of spots. In late summer they move back again to the twigs, hiding away for winter.

Fig. 471. — Apples deformed by the Pear-leaf Blister-mite. Original.

Treatment consists in spraying in winter with lime-sulphur solution, so as to kill the hibernating mites. In summer they cannot be reached by any spray material because of their feeding habits.

The Apple Leaf Trumpet Miner

(*Tischeria malifoliella* Clem.)

Characteristic, trumpet-shaped mines in the upper surface of apple leaves indicate the presence of this insect. Usually the mines are not more than a half inch long, beginning with a quite narrow brown or dead area and enlarging rapidly to their maximum width.

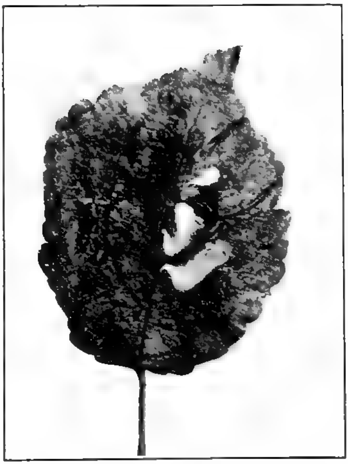

Fig. 472. — Work of the Apple Leaf Trumpet Miner. Original.

There are from two to four generations annually. The winter is passed by the full-grown larva in its mine in fallen leaves. The tiny adult moths emerge in the spring with the expanding of apple foliage.

Late fall or early spring plowing to bury fallen leaves is the simplest means of control.

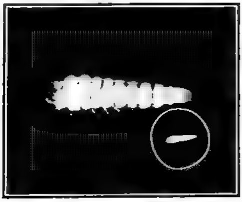

FIG. 473.—Larva of the Apple Leaf Trumpet Miner. Enlarged and natural size. Original.

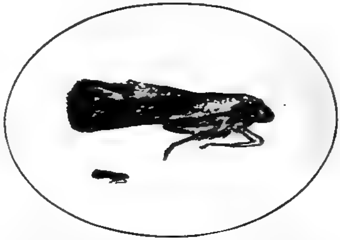

FIG. 474.—Adult of the Apple Leaf Trumpet Miner. Enlarged and natural size. Original.

The Blackberry Leaf-miner (*Metallus rubi* Forbes)

The leaves of blackberry sometimes show numerous blotch mines, caused by a small larva working within the leaf tissue. Occasionally the foliage is severely injured. There are two to four broods in a summer, the later ones doing the most damage. The adult is a small sawfly.

No direct means of control are known except to remove infested leaves early in the season.

The Resplendent Shield-bearer (*Coptodisca splendoriferella* Clem.)

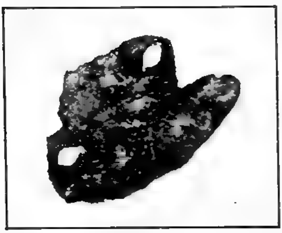

FIG. 475.—Cocoons of the Resplendent Shield-bearer on a piece of bark. Original.

FIG. 476.—The Resplendent Shield-bearer. Apple leaf showing mines and sections removed.

Occasionally apple, plum, or quince show the characteristic work of this insect. Round, transparent mines are made in the leaves, and

after a time the larva feeding within cuts out the infested area bodily and carries it to a twig or branch, where it uses it as a shelter until the following spring. There is one brood annually.

A winter spraying with lime-sulphur solution or other strong contact insecticide will kill the overwintering form.

The Four-lined Leaf-bug (*Pœcilocapsus lineatus* Fab.)

A sucking bug, about half an inch long, with four short black stripes on its back, sometimes injures the leaves of currants, gooseberries, or other plants by its feeding punctures. Spots where the bug has been feeding turn brown, and sink a little below the level of the leaf. In time the entire foliage, or that toward the tips of the twigs, may be killed.

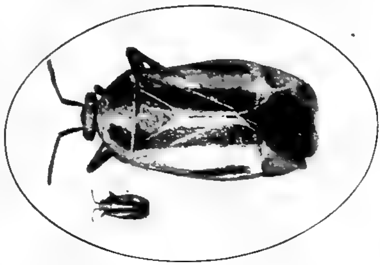

FIG. 477. — The Four-lined Leaf-bug. Enlarged and natural size. Original.

In early spring, when first hatched, the bugs are very small, bright red, and have no wings. They feed on only the tenderest terminal foliage. They become full grown in June, and the female lays eggs in slits cut in the stems of the food plants. In the North there is one generation, hibernation taking place in the egg stage; in the Southern states there may be a second brood.

The young nymphs may be killed with a contact insecticide, such as 10 per cent kerosene emulsion. The adults are best destroyed by brushing them from the plants into pans containing a film of kerosene. It is difficult or impossible to control the adults by spraying.

The Grape Leaf-hopper (*Typhlocyba comes* Say)

Tiny, active insects suck the juices from grape leaves, making numerous very small white spots. If attack is severe, the leaves shrivel, turn brown, and die.

The adult insect is one tenth of an inch long, light yellowish in color, with green markings on its wings. It has strong legs, jumps

quickly, and flies readily. Attack by it is most noticeable in September. The nymphs look like the adults, except that they are smaller

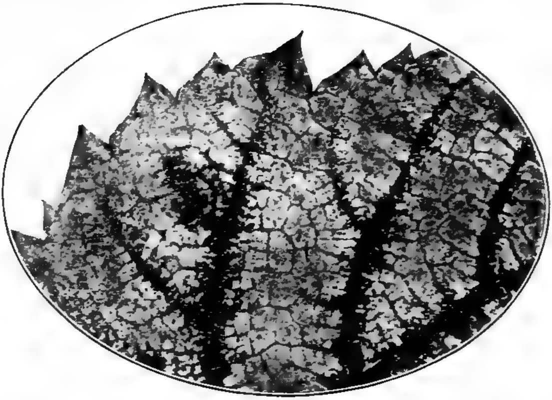

Fig. 478. — Work of the Grape Leaf-hopper. Original.

and have no wings. Both adults and nymphs feed on the under surface of the leaves.

The adults leave the grape in October and migrate to neighboring vegetation. They overwinter in dead, fallen leaves, clumps of grass, or any similar protection. In spring they feed first on weeds, then migrate back to the grapes and feed on the young shoots and leaves. Eggs are laid in the tissue of the grape leaves in June and July. Nymphs emerge shortly, and are numerous in July and August. The nymphs do not hop or fly, merely running around over the leaves. There is one generation each year.

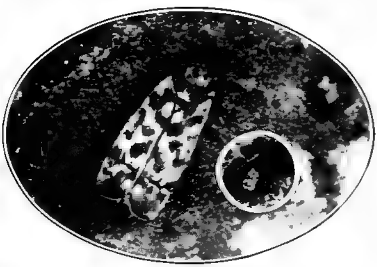

Fig. 479. — The Grape Leaf-hopper. Enlarged and natural size. Original.

Cleaning up rubbish in the vineyard is only of nominal value, since the adults migrate in October to neighboring hiding places. The best

means of control consists in spraying thoroughly with tobacco extract as soon as nymphs appear. The spray must be directed to the under side of the leaves and must be applied before the insect has reached the winged stage, in order to be effective.

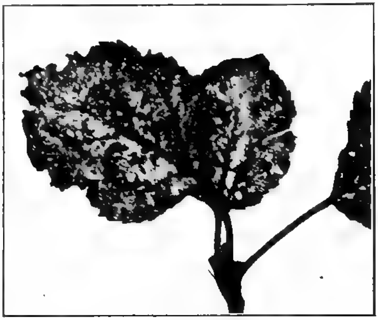

FIG. 480.—Work of the Apple Leaf-hopper. Original.

The Apple Leaf-hopper

(*Empoasca mali* Le B.)

A very small whitish insect, winged and active in its mature stage, swarms on the leaves of apple trees and sometimes on other foliage, sucking the juice of the leaf. The feeding punctures cause tiny white spots, which in time become numerous enough to give the foliage a distinctly bleached appearance. On young trees, and especially on nursery stock, the attack usually results in a curling of the tender leaves, somewhat resembling the work of plant lice. The insect winters partly as adults in rubbish, partly as eggs in the bark of the trees. There are several generations in the course of the summer.

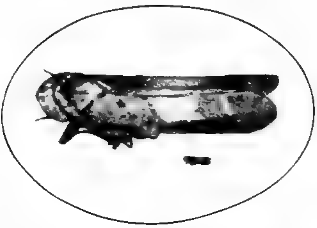

FIG. 481.—The Apple Leaf-hopper. Enlarged and natural size. Original.

In orchard trees spraying with a contact insecticide, such as tobacco extract, will kill many of the leaf-hoppers if the material is applied early in the season, before the winged stage appears. On nursery stock a desirable preventive measure is dipping in soap solution.

The Pear Psylla (*Psylla pyricola* Foerst.)

The pear psylla is a minute, sucking insect, wingless in its immature stages, but active and winged as an adult. It sucks the juices of the

buds and newly forming leaves. When the pests are numerous, the leaves are killed, and often are blackened through the growth of a fungus on the sticky honeydew secreted by the insect.

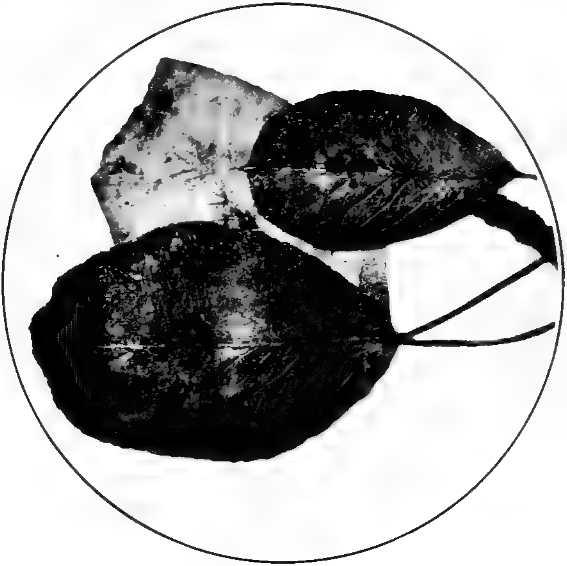

FIG. 482.—Work of the Pear Psylla. Original.

The adult is very small, dark in color, its body showing characteristic markings. It has four membranous wings. Seen through a hand lens it looks like a tiny cicada, or "locust."

FIG. 483.—Adult Pear Psylla. Enlarged and natural size. Original.

The adults hide away for the winter in crevices of the bark, and emerge and lay eggs at the time that the buds are swelling. The young are numerous when the blossoms are falling. There are four or five broods in a season.

The pest may be controlled by

spraying with a contact insecticide, such as tobacco extract, to kill the hibernating adults. To do this the bark should be scraped, and the spray applied very early in the spring. A second method consists in spraying with winter-strength lime sulphur to kill the eggs, applying the material when the buds are swelling. Finally, a contact insecticide may be used to kill the nymphs, applying the spray when the blossoms are falling. Any one of these treatments, thoroughly applied, is effective.

Plant Lice on Apple Foliage

Three species of small, soft-bodied, sucking lice are commonly found infesting the foliage of apples: the Apple Aphis (*Aphis pomi* DeG.); the Rosy Apple Aphis (*Aphis sorbi* Kahl.); and the European Grain Aphis (*Siphocoryne avenæ* Fab.). In addition to these the Clover Aphis (*Aphis bakeri* Cowen) is sometimes found on apple late in the fall and in the early spring.

FIG. 484. — Work of the Apple Aphis on terminal shoot. Original.

Infestation may first be observed on the young shoots which are found completely covered with very small, green or pinkish lice. About this time, also, it may be noticed that many of the lice are clustering on the under sides of leaves near the ends of shoots, causing them to curl.

Again the first evidence

of injury may be observed on the expanding buds, on which clusters of the lice are found, their work resulting in deforming the young leaves or the blossoms, or in considerable injury to the young fruit.

FIG. 485. — Adults of the Apple Aphis on twig. Enlarged and natural size. Original.

The life histories of these various species are not the same, in spite of the similarity in their superficial appearance and their initial work.

The Apple Aphis (*Aphis pomi*) passes the entire season on the apple. In the winter it is in the egg stage, large numbers of the small, black shining eggs often being found on terminal twigs. The first generations in summer are wingless, but in later generations winged individuals develop. This species is characteristically bright green in color, with black, rather slender honey tubes. It is one twelfth of an inch long. Usually the lice observed on tender shoots and beneath curled terminal leaves belong to this species or to the following.

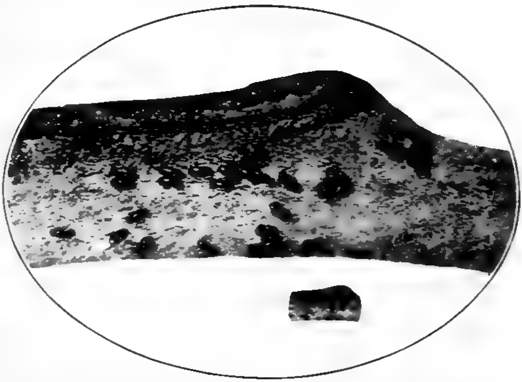

FIG. 486. — Eggs of the Apple Aphis on twig. Enlarged and natural size. Original.

The Rosy Apple Aphis (*Aphis sorbi*) hatches from eggs that have remained on the apple throughout winter, but with the third generation migrates to other food plants. This is a slightly larger species. The wingless female is one tenth of an inch long, bluish in color, and has yellow honey tubes tipped with black. The winged female has a black thorax and a red abdomen.

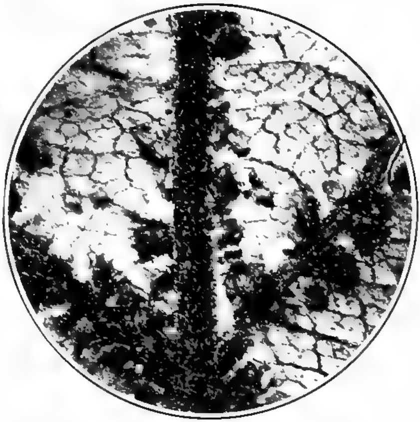

Fig. 487. — Adults of the Apple Aphis clustered along veins of leaf. Enlarged. Original.

The European Grain Aphis (*Siphocoryne avenæ*) is found in summer on small grains, but for the most part migrates in the fall to apple, pear, or related trees, where its winter eggs are laid. It develops in the spring like the preceding species, leaving the fruit trees with the coming of the third generation. On apple trees it is commonly first observed clustered on the expanding buds.

Fig. 488. — Work of Aphis on young fruit. Original.

The Clover Aphis (*Aphis bakeri*) rears its summer generations on clover or alfalfa. These lice are light yellow or pink. Usually they leave the clover in the fall, passing through a winter egg stage on apple or pear. The first generation from these eggs

in the spring are dark green or red, and have honey tubes yellow throughout.

Ants are apt to be found in attendance on any of these aphids. They come to secure the substance that the lice excrete, commonly called "honeydew."

Control of these insects is best achieved by prompt application of a contact insecticide as soon as the lice are first seen. They are readily killed by spraying with tobacco decoction, or 7 per cent kerosene emulsion, taking pains to do a thorough job. The tobacco extract will spread more readily if soap is dissolved in it.


FIG. 489. — The Cherry Aphis. Original.

The Cherry Aphis

(*Myzus cerasi* Fab.)

Injury by this plant louse is usually noticed soon after the leaves have unfolded in the spring. It will be found clustered thickly on tender shoots or leaves. It is a shining black aphid, and if examined under a lens will be found to have long, slender honey tubes. The summer generations are wingless, but in the fall winged individuals are produced. So far as known, this species is never found on any other host than cherry. It passes the winter in the egg stage.

To control, spray with tobacco extract or with kerosene emulsion as soon as the lice are first seen.

The Currant Aphis (*Myzus ribis* Linn.)

Like most other plant lice this species causes a curling up of the foliage infested. Both currants and gooseberries are subject to attack. The leaves curl tightly, and their upper surfaces show distinct raised areas or blisters, between the veins.

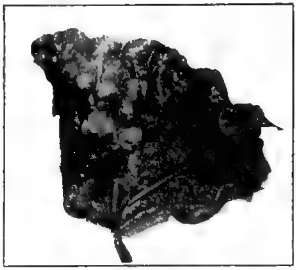

Fig. 490. — Work of the Currant Aphis. Original.

The lice are one twelfth of an inch long, mottled green, and have red eyes. The pest passes the winter as shining eggs, attached to the woody parts of the plants.

Contact sprays, such as tobacco extract or kerosene emulsion, will kill them, but should be applied before the leaves are badly curled.

The Grapevine Aphis (*Macrosiphum viticola* Thos.)

Dusky, soft-bodied plant lice with greenish legs cluster on the tender leaves and young shoots of grapevines. They appear in the early part of the season, and usually are not noticed after growth is well established

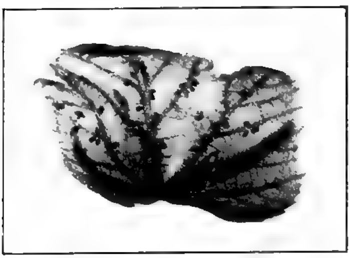

Fig. 491. — Work of the Grapevine Aphis. Original.

Fig. 492. — The Grapevine Aphis. Greatly enlarged. Original.

in summer. Spraying with tobacco extract or kerosene emulsion will kill them.

Plant Lice on Peach Foliage

Two species of plant lice are common on peach foliage. They are especially likely to do notable injury in the spring, clustering on the tender shoots, curling the leaves, and sometimes dwarfing and distorting the forming fruit.

The Green Peach Aphis (*Myzus persicæ* Sulz.) hatches in early spring from eggs laid in crevices of the bark. The first lice are pink, but the next generation are light green, often with darker green stripes across the abdomen. These in turn give birth to a third brood, many of which, unlike the preceding, have wings. The latter fly to new food plants, and for the next two or three months breed on various garden crops, such as tomatoes, spinach, cabbage, and many others. In the fall another winged generation returns to the peach or other related trees, and the winter eggs are laid.

Fig 493. — The Black Peach Aphis. Aerial form. Original.

The measures of control are spraying with 7 per cent kerosene emulsion or with tobacco extract when the lice are first observed.

The Black Peach Aphis (*Aphis persicæ-niger* Er. Sm.) lives the year round on peach. It differs from the preceding in the fact that colonies are maintained on the roots both summer and winter, as well as the colonies on the leaves and twigs in summer. The full-grown aphid is shining black. Control of this species must be directed toward the root-inhabiting forms as well as those above ground. In fact the former are often much the more abundant, while few or none may be seen on the foliage. See page 229.

The remedy for those below ground is to draw away the earth from around the base of the tree, in a circle 4 or 5 feet in diameter, and apply 2 to 4 pounds of tobacco dust. The lice on the foliage are best treated with a spray of tobacco extract, or 7 per cent kerosene emulsion.

Plant Lice on Plum Foliage

Three species of plant lice are more or less common on the leaves and tender shoots of plums, especially in the spring. They tend to collect in clusters, the leaves are more or less distorted and curled by their attack, and the flowers and fruit may be badly injured. After two or three generations they leave the plum and fly to other hosts.

The Brown Plum Aphis (*Aphis setariæ* Thos.) spends the summer on various grasses. It is dark in color and has white-marked legs and antennæ.

The Mealy Plum Aphis (*Hyalopterus arundinis* Fab.) is covered with a bluish white powder. The back of the body bears three darker obscure stripes, and the shape of the body is rather elongated. The honey tubes are short and rather thick. In summer the lice are found on grasses.

The Hop Aphis (*Phorodon humuli* Schr.) flies to hop-vines in early summer, and is a pest rather on the latter than on the plum.

The treatment is a thorough spraying with tobacco extract or 7 per cent kerosene emulsion just as soon as the lice are first observed. It is important to apply the spray promptly, before the leaves are badly curled.

The Clover Mite (*Bryobia pratensis* Garm.)

This tiny, 8-legged mite swarms over the foliage of clover in some seasons. In the West it feeds also on the leaves of various fruit trees, sucking their juices. The leaves attacked lose their green color and grow yellow and sickly. The mites survive the winter for the most part in the egg stage on the bark of fruit trees. See page 208.

In summer trees should be sprayed with sulphur, 10 pounds to 50 gallons of water, adding soap so that the sulphur will not float on top of the water, and keeping the mixture well stirred. Spraying with

lime-sulphur solution in early spring, just as the buds are starting, is also an effectual treatment, resulting in killing the eggs. Use the material at the same strength as for San José scale.

Red Spider on Fruit Tree Foliage (*Tetranychus bimaculatus* Harvey)

Another mite attacking the foliage of fruit trees, and sucking the juices, is the common red spider so often troublesome in greenhouses. It hibernates in the soil near the trees. When feeding on fruit tree foliage, this mite usually is green in color. It has two dark spots on the abdomen. It spins a very thin web on the under leaf surface, and feeds beneath. This habit will readily distinguish it from the clover mite just described. See page 207.

Spraying with sulphur, 10 pounds to 50 gallons of water, is an effective treatment. Add soap to make the sulphur mix with the water, and keep the mixture well stirred. Screen the sulphur to remove lumps before adding to the water.

The Rose-chafer (*Macrodactylus subspinosus* Fab.)

Hordes of long-legged, sprawling beetles attack the blossoms of grapes, ripening fruit, such as cherries, and the blossoms of flowers.

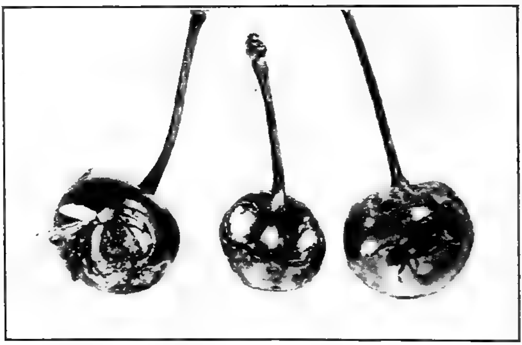

FIG. 494. — The Rose-chafer. Adults and work on cherries. Original.

The body of the beetle is a little over one third of an inch long, rather slender and cylindrical, and dull greenish or golden yellowish in color.

Because of its long legs the insect looks larger than it is. In habits it is sluggish. Holes are eaten in fruit, and the sides of unopened grape blossoms are eaten out so as to get at the stamens and pollen within. In flowers the beetles attack especially the central parts.

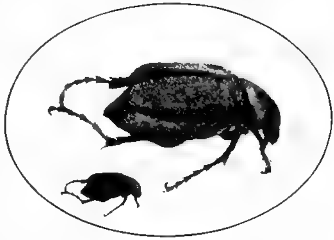

Fig. 495. — The Rose-chafer. Enlarged and natural size. Original.

The insect breeds in sandy ground. The larva is a small, whitish grub, and feeds on grass roots. In the fall it goes down below frost line, returning in spring and transforming. The adults come out in June. Eggs are laid in the ground, ½ to 4 inches below the surface. Egg-laying continues over a considerable period. There is one generation each year.

Direct control is possible by spraying thoroughly with arsenate of lead, 5 pounds to 50 gallons of water, to which should be added 1 gallon of molasses. Without the molasses the spray is not so effective, as the beetles will avoid the parts of the plant that are coated with poison and seek out places where none of the spray has lodged. Spray first when the beetles are due, and again in one week.

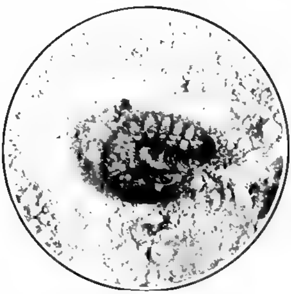

Fig. 496. — Larva of the Rose-chafer. Original.

Hand picking is feasible in flower gardens. If possible, break up the adjacent breeding grounds, especially sandy fields in sod or weeds. The insect does not breed in ground kept in clean cultivation.

The Indian Euphoria (*Euphoria inda* Linn.)

Ripening peaches and pears sometimes are eaten into by brownish, heavy-bodied beetles, about half an inch long, their wing covers marked with irregular darker patterns. They are slow moving and not easily

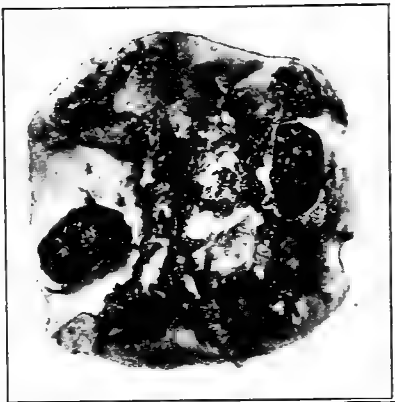

FIG. 497.—The Indian Euphoria. Adults at work on peach. Original.

disturbed. The species is two brooded, and it is the adults of the second brood that are found on the fruit. The larvæ are thick-bodied grubs, and live on decaying vegetable matter.

When the adults are numerous enough to be troublesome, fruit should be picked a little before it is quite ripe, or the beetles may be attracted to a heap of decaying fruit.

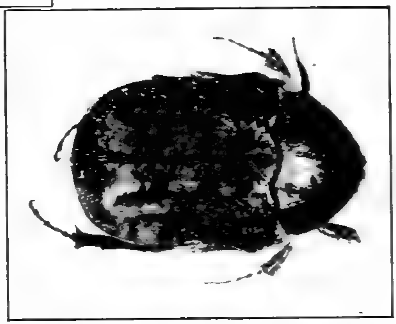

FIG. 498.—The Indian Euphoria. Adult enlarged. Original.

The Green June Beetle
(*Allorhina nitida* Linn.)

The feeding habits of this beetle are similar to those of the Indian Euphoria. Ripe fruits, especially peaches, pears plums, or occasionally small fruits, are attacked and their substance eaten out. The beetle is a handsome fellow, its upper surface a velvety green, bordered with brown. The larva looks much like a common white grub, and feeds on decaying vegetable matter.

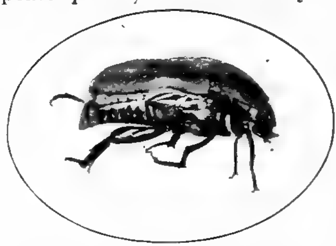

FIG. 499.—The Green June Beetle. Slightly enlarged. Original.

The means of control of the adults is the same as that recommended for the Indian Euphoria.

The Green Fruit Worm (*Xylina antennata* Walk.)

Occasionally the young fruits of apple, pear, or strawberry are eaten into by light-colored naked caterpillars, faintly striped with yellow. Usually the worms eat shallow, irregular holes in the sides of the fruit.

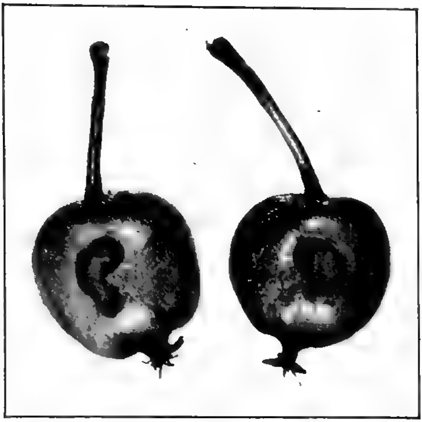

FIG. 500. — Apples injured by Green Fruit Worms. Original.

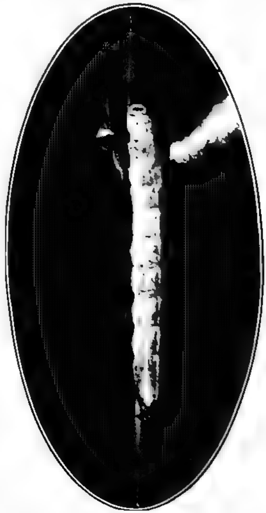

FIG. 501. — A Green Fruit Worm. Original.

They are seldom found in orchards that are sprayed early in the season, especially if arsenical sprays are applied to the buds before blooming time. When injuring fruit, the worms may be jarred from the trees and killed. It is difficult to poison them at this time, because they are nearly full grown and are resistant to arsenicals; therefore spraying the fruit with poisons is not likely to be satisfactory.

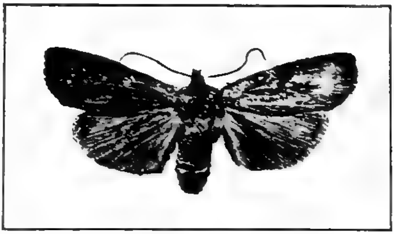

FIG. 502. — Adult of a Green Fruit Worm, *Xylina laticinerea*. Original.

Xylina laticinerea Grt. is another common species of identical habits.

The Cranberry Fruit-worm (*Mineola vaccinii* Riley)

The growing berries are eaten into and the contents devoured by a small, greenish caterpillar, half an inch long when full grown. The work begins when the berries are small, and continues until they are coloring up, the caterpillar entering one berry after another by a small hole, usually thus destroying three or four by the time it is full grown.

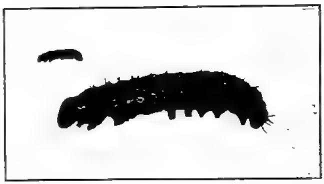

Fig. 504. — Larva of the Cranberry Fruit-worm. Enlarged and natural size. Original.

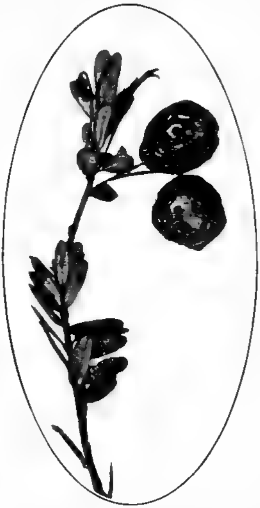

Fig. 503.—Work of the Cranberry Fruit-worm. Original.

Infested berries ripen prematurely. Winter is passed by the caterpillar in a silk cocoon in the sand.

Where water is abundant, reflow at once after picking, drawing off the water again after ten days. Paris green or arsenate of lead may be used when the worms first appear, but must be applied thoroughly and repeated.

The Gooseberry Fruit-worm (*Zophodia grossulariæ* Pack.)

Active, pale green, shining caterpillars, three fourths of an inch long when mature, eat into the fruit of gooseberries and often web a number of berries together. When disturbed, they promptly let themselves down by a silk thread. There is one generation annually. Hibernation takes place on the ground in the pupal stage.

Fig. 505. — Work of the Gooseberry Fruit-worm. Slightly enlarged. Original.

Hand picking is often the simplest means of control. If necessary, Paris green or arsenate of lead may be applied in order to stop a bad outbreak, but if the fruit is of good size, it will not be safe to use it. Plowing or cleaning up rubbish in the fall will help to reduce injury the following season.

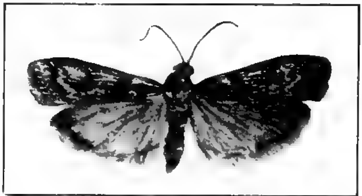

Fig. 506. — Adult of the Gooseberry Fruit-worm. Slightly enlarged. Original.

The Raspberry Span-worm

(*Synchlora æerata* Fab.)

The fruit of raspberries sometimes is eaten by grayish or yellowish span-worms, three fourths of an inch long when mature. They are peculiar in their habit of decorating themselves with bits of flowers or leaves stuck

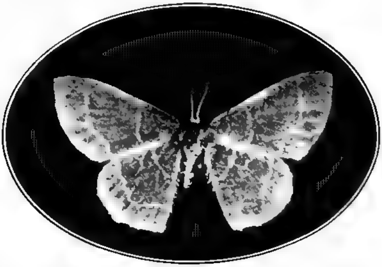

Fig. 507. — Adult of the Raspberry Span-worm. Slightly enlarged. Original.

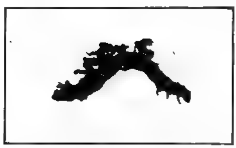

Fig. 508.—The Raspberry Span-worm. Original.

on the short spines on the sides of their bodies. The adult is a delicate pale-green moth.

Hellebore is the only poison that is safe to use on fruit of this kind.

FIG. 509. — Work of Climbing Cutworms. At left, larva of *Peridroma margaritosa.* Original.

Climbing Cutworms (*Noctuidæ*)

The expanding buds of fruit trees, especially in the case of newly set stock, sometimes are eaten out and destroyed, no worms being in evidence when the trees are looked over, although the trouble continues. This is the characteristic work of certain cutworms, which, in the lack of other food to their liking, climb the trees and de-

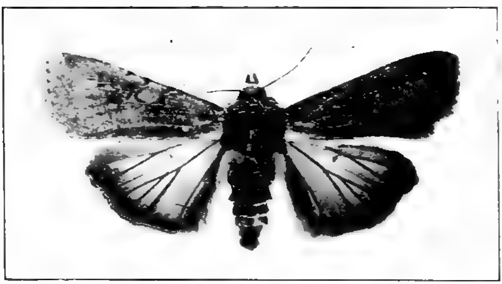

FIG. 510. — Adult of Cutworm, *Peridroma margaritosa.* Original.

vour the tender unfolding tissues, working at night and hiding by day.

The remedy is a prompt application of Paris green or arsenate of lead to the trees, so as to coat the buds. Instead of this, or in addition to it, a little poison bran mash may be placed at the base of each tree.

Occasionally the buds of greenhouse plants are attacked in similar manner. A liberal dose of poison bran mash is then indicated, scattered on the the ground throughout the attack.

The Imbricated Snout Beetle (*Epicærus imbricatus* Say)

Occasionally a rather large snout-beetle, its wings banded in zigzag pattern with brown and gray, its snout short and broad, feeds on the buds or young foliage of tree or bush fruits. See page 167. The beetle cannot fly. The larva lives in the ground.

Paris green or arsenate of lead applied early as a spray will check the insect's work.

The New York Weevil (*Ithycerus noveboracensis* Först.)

Large, gray snout-beetles, half an inch long and marked with black, appear on fruit trees in early spring, gnaw into the tender twigs, and eat into the base of buds. The larval stage is passed in the twigs of oak and hickory, and injury is always greatest on fruit trees close to woodland. Thorough spraying with Paris green or arsenate of lead early in the spring when the buds are swelling is the only direct means of control.

Fig. 511. — The New York Weevil. Slightly enlarged. Original.

The Pear Thrips (*Euthrips pyri* Danl.)

The pear thrips is a minute insect attacking the newly opening flower and leaf buds of pear, and, in California, those of prune, cherry, almond, peach, and apricot.

The evidence of attack is a distorting, blackening, or complete killing

of the opening buds. The adult thrips, which causes this injury, is a small, winged insect with sucking mouth parts. It comes out from its winter hiding place in the ground at the time that growth first starts, and as soon as the bud scales have parted, works its way down into the flower, puncturing the tissues and sucking the juices. Egg laying begins later, and the immature thrips feeds on the tender leaf tissues for two or three weeks. Then it drops to the ground, penetrates the soil to a depth of three or four inches, and remains there until the following spring.

FIG. 512. — Expanding buds killed by the Pear Thrips. Original.

Direct control is possible by means of timely and thorough spraying with tobacco extract (the commercial preparation), to which has been added distillate oil emulsion so as to make a 2 per cent solution. The emulsion is prepared by dissolving 8 pounds of whale-oil soap in 3 gallons of boiling water, and adding 5 gallons of distillate oil (28 degrees Baumé), at once driving the mixture through a spray pump into a tank or barrel. One gallon of the emulsion to 24 gallons of the tobacco water will give a 2 per cent solution. The spraying must be done just as the buds begin to unfold, and may need to be repeated.

FIG. 513. — The Pear Thrips. Enlarged to fifteen times natural size. Original.

Deep plowing followed by thorough cultivation in the fall, to disturb and destroy the pupating larvæ, is of value.

The Flower Thrips (*Euthrips tritici* Fitch)

In the Southwest the opening flower and fruit buds of various fruit trees are subject to serious injury by minute, slender, active insects which enter them in large numbers and suck the juices of the tender, growing parts. The adults have two pairs of narrow, fringed wings. The younger stages are wingless, but do equal damage with the adults. The injury is sometimes so severe that young trees are killed.

An effective remedy is thorough spraying with tobacco extract. Distillate oil emulsion may be added to this, as recommended for the pear thrips. The Flower Thrips is illustrated on page 26.

The Peach Bud Mite (*Tarsonemus waitei* Bks.)

Young peach trees in nurseries sometimes suffer severe injury to the terminal bud or shoot, due to the work of an exceedingly small, eight-legged mite. The main shoot dies, or fails to develop, and the tree then puts out several new shoots below, destroying its symmetry and rendering it worthless for transplanting.

Some of the mites hibernate under bud scales, but it is possible that others may spend the winter on some other host plant.

Careful pruning will help the tree to overcome injury and send out a new terminal shoot. Lateral buds that start up should be removed, in order to avoid a bushy top. Spraying with self-boiled lime sulphur early in the growing season may kill most of the mites.

The Grape-blossom Midge (*Contarinia johnsoni* Sling.)

The flower buds of early varieties of grapes sometimes fail to develop properly through the work of this tiny insect. Buds attacked show an abnormal swelling or redness, and only occasional berries will set, so that the bunches of fruit will be straggling, if not entirely wanting.

The injury is due to the larvæ of a minute midge that appears just as the buds are beginning to swell and lays its eggs in the opening ends. After three weeks the larvæ are full grown, drop to the ground, and remain there until the following year.

Spraying with tobacco extract when the buds first begin to swell

will largely avert injury. The material should be applied thoroughly and with ample force.

The Plum Curculio (*Conotrachelus nenuphar* Herbst.)

The fruits of plum, apple, and cherry, and sometimes of peach, are subject to injury by this pest. Round or crescent-shaped punctures are made in the sides of the fruit by the adult beetles in feeding and egg laying. Within the fruit a grub or worm develops.

The punctures made by the adult are of two sorts. In feeding, the beetle gnaws out a small, round hole. When egg laying, it makes a crescent-shaped cut around the point at which it has inserted its egg in the fruit. These injuries are especially serious on young fruit, causing them to grow gnarly and misshapen.

Fig. 514. — Egg-laying punctures of the Plum Curculio. Slightly enlarged. Original.

Fig. 515. — The Plum Curculio. Enlarged and natural size. Original.

The beetle itself is quite small, three sixteenths of an inch in length, dark in color with lighter markings, and has four ridges or humps on its back. Its mouth parts are at the end of a snout. The larva or grub is whitish, one third of an inch long, and entirely without feet.

The beetles spend the winter in rubbish or similar shelter in or near

the orchard. Early in the spring they come out; and as soon as the buds are unfolding feed sparingly on the tender tissues. When fruit has set, egg laying begins and continues for several weeks. Infested fruit is apt to drop. The larva enters the ground to transform. There is a second generation in midsummer, the adult of this hiding away until the following spring.

FIG. 516. — Larva and work of the Plum Curculio in cherry. Slightly enlarged.

Control is best directed toward killing the overwintering beetles by spraying the trees with arsenate of lead or Paris green as soon as the buds are fairly opening in the spring, repeating later if necessary. Where trees are sprayed at the time that the petals fall, this will constitute the second spraying. In addition, it will pay to eliminate rubbish as far as possible from the orchard or its neighborhood, and to adopt clean cultivation. The former will destroy the hiding places of the beetles, and the latter will kill many of the larvæ that have entered the soil to transform. The destruction of fallen fruit at frequent intervals is of value, where feasible.

On plum trees the beetles may be controlled by jarring them from the trees in the early morning, spreading a sheet beneath to catch them.

The Apple Curculio (*Anthonomus quadrigibbus* Say)

Usually the curculio attacking the fruit of the apple is the plum curculio. Sometimes the depredator is the pest here considered. The work of this species may be distinguished from that of the plum curculio by the fact that the punctures that the apple curculio makes are comparatively inconspicuous. The beetle itself is similar to the plum curculio, but is stouter and chunkier, has a larger snout, and has four very prominent humps on its back.

The life round is much like that of the other species. The adults hibernate in any convenient shelter, and lay their eggs in the young fruit. The larva is a footless grub. Its body is enlarged in a sort of hump back of the head. It pupates in the soil, and the adults emerge in the latter part of summer, soon going into hibernation.

Fig. 517. — The Apple Curculio. Enlarged and natural size. Original.

On small trees jarring is an effective plan. On larger trees early spraying with arsenate of lead or Paris green will poison many of the beetles. Rubbish of all sorts should be kept cleaned up, in order to eliminate winter hiding places.

The Plum Gouger (*Anthonomus scutellaris* Lec.)

The plum gouger is a brownish beetle, one fourth of an inch long, and may be distinguished from the plum curculio by the absence of the characteristic humps found on the wing covers of the curculio.

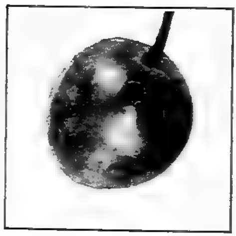

Fig. 518. — Feeding puncture made by the Plum Gouger. Original.

Early in the season holes are eaten in the base of the flower, and the beetle feeds on the part within that would later become the fruit. After the plums are of some size the adult punctures them and lays an egg within, the grub living inside the forming seed. The adult does not make a crescent-shaped cut around

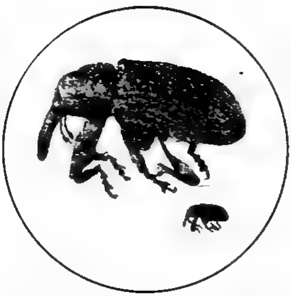

Fig. 519. — The Plum Gouger. Adult, enlarged and natural size. Original.

the punctures as does the curculio. In feeding the beetle gouges out small round holes.

The grub pupates inside the fruit, and then emerges as an adult. Infested plums usually drop before the adult is due to emerge. Hibernation takes place in the adult stage.

Jarring the trees to catch the beetles is a fairly effective treatment. Prompt destruction of fallen fruit is of value, where practicable. Early spraying with arsenate of lead or Paris green, as recommended for the plum curculio, is likely to kill most of the hibernating adults.

Fig. 520. — Work and larva of the Grape Curculio. Slightly enlarged. Original.

The Grape Curculio
(*Craponius inæqualis* Say)

The fruit of grapes is sometimes found infested by a white, fleshy, inactive grub, footless, and tapering towards each end. This is the larval stage of the grape curculio. It may readily be distinguished from the other grub commonly found in grapes, that of the grape berry moth, which has distinct legs, is more slender and cylindrical, and is greenish or light purplish in color.

Fig. 521. — The Grape Curculio. Enlarged and natural size. Original.

The adult beetle is one tenth of an inch long, quite broad, and brown in color. It appears from hibernation when the grapes are blossoming, and feeds on the foliage. Later it begins laying eggs in the berries. The grub, when mature, drops to the ground, transforms in the soil, and a new generation of beetles is abroad in late summer, shortly entering hibernation. There is thus one generation each year.

Spraying with arsenate of lead or Paris green will readily poison the adults because of the long time during which they feed on the grape foliage. The poison should be applied just after the grapes finish blooming. Vineyards that are sprayed regularly with arsenicals for other pests, such as the grape berry moth, will not find this insect in evidence. If it is found that many berries are infested, these should be collected and destroyed.

FIG. 522. — The Quince Curculio. Enlarged and natural size. Original.

The Quince Curculio

(*Conotrachelus cratægi* Walsh)

Both the adult and the grub of this species injure the fruit of quinces. The former eats holes into the fruit, when it is still small. The latter burrows within the flesh, making wandering cavities, and finally eats its way out through the skin. Quinces that have been punctured by the adult grow misshapen.

The adult curculio is a small, snout beetle, one fourth of an inch long, its body broadest at the middle and its back marked with seven longitudinal ridges. Eggs are laid under the skin of the young fruit. The grubs enter the ground when full grown, and remain there until the following spring.

The only effective remedy is to jar the beetles from the trees in the early morning, catching them on sheets and destroying them. The application of poison sprays is of no avail.

FIG. 523. — Work of the Strawberry Weevil. Original.

The Strawberry Weevil (*Anthonomus signatus* Say)

The work of the strawberry weevil is conspicuous and unmistakable. Flower buds, soon due to open, are seen to droop and bend over, and in a few days most of them will break off and fall to the ground. If one is cut open at this time, a small, white grub will be found within, feeding on the inner tissues of the bud. After laying an egg in a bud the beetle punctures the stem just below, so that the bud droops and soon falls. The grub, when full grown, transforms within the bud on the ground. The new lot of beetles feed for a time in various places and then hide away until the next year. Only staminate varieties are attacked.

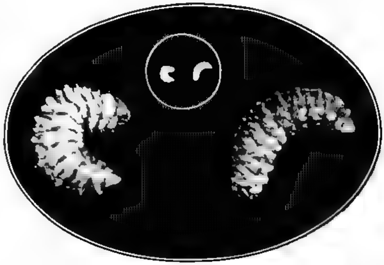

Fig. 524.—Larvæ of the Strawberry Weevil. Enlarged and natural size. Original.

Early spraying with arsenate of lead or Paris green will kill many beetles. The material should be applied as soon as the first buds begin forming. All rubbish should be cleaned up around the field. When badly infested, the plants may be burned over at once after picking. Wild blackberries and strawberries should be destroyed. It should be remembered also that pistillate varieties are immune from any injury.

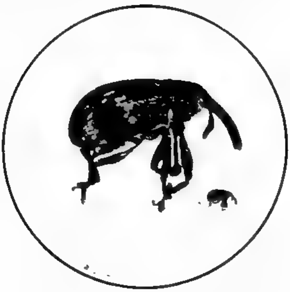

Fig. 525.—The Strawberry Weevil. Adult, enlarged and natural size. Original.

The Codling Moth (*Carpocapsa pomonella* Linn.)

A pinkish, rather fleshy worm eats cavities within the fruit of apples, especially through and around the core, and finally bores a large hole to the surface.

FIG. 526.—Section through apple showing characteristic work of the Codling Moth. Original.

The adult is an inconspicuous, brownish moth, and emerges in the spring from a cocoon usually located under rough scales on the bark of the tree. Eggs are laid on leaves or sometimes on the fruit itself. The larva makes its way to the nearest apple and enters the young fruit through the calyx end. It feeds for the rest of its life inside, and when mature, eats its way out, travels to a

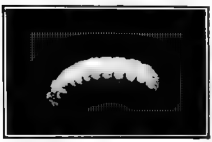

FIG. 527.—Larva of the Codling Moth. Slightly enlarged. Original.

FIG. 528.—Cocoon of the Codling Moth underneath a piece of bark. At the top, the pupa. Original.

FIG. 529.—The Codling Moth. Adult, slightly enlarged. Original.

suitable shelter, and spins its cocoon. Here it may remain until the next spring, but in the Central and Southern states there is a second brood. The larvæ of the latter often feed merely on the surface of the apple instead of boring into it.

Control consists in spraying with arsenate of lead. The most important point is to apply the material just after the blossoms fall, while the calyx cup is still open, and to direct the spray so that the poison will lodge in the blossom end of the upturned apples. A second spraying about three weeks later, at the time when the worms are just hatching, will augment the value of the first, because the larvæ feed a little on the leaf before going to the apple. For the second brood in midsummer arsenate of lead is used, as for the first brood.

Fig. 530. — The time to spray for the Codling Moth. The calyx still open. Original.

Fig. 531. — Too late to spray for the Codling Moth. The calyx closed. Original.

The Lesser Apple Worm

(*Laspeyresia* (*Enarmonia*) *prunivora* Walsh)

Injury to the fruit of apples by the lesser apple worm is often confused with that of the codling moth, but is distinct on careful examination. Early in the season the injury is apt to take the form of small cavities eaten

into the surface of the fruit at the calyx end. When the fruit is ripening, the damage is more conspicuous and more serious. At this time the second brood larvæ are active, and blotch mines are made just under the skin of the apple. The larva within may penetrate the pulp to a depth of half an inch, or occasionally nearly to the core. Frequently the work goes on for some time after the fruit is picked.

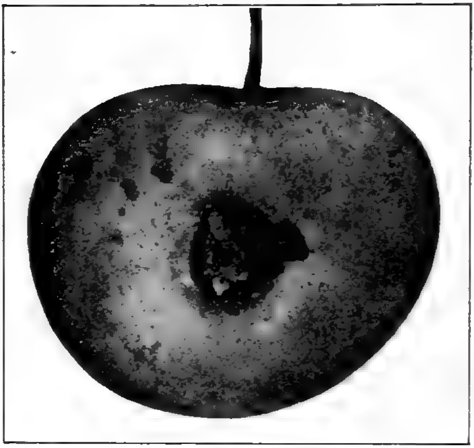

FIG. 532. — Injury by the Lesser Apple Worm. Original.

The parent insect is a small moth. Eggs are laid soon after the fruit is set. The full-grown larva is one fourth to one third of an inch long. Pupation takes place under scales of bark on limbs, or sometimes in the calyx end of the fruit. The larvæ of the second brood pass the winter in inconspicuous cocoons, in situations similar to those of the first brood, or in barrels in which fruit has been placed.

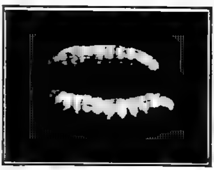

FIG. 533. — Larvæ of the Lesser Apple Worm. Enlarged. Original.

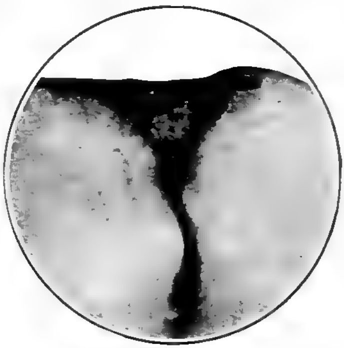

FIG. 534. — Section through apple showing characteristic work of the Lesser Apple Worm. Enlarged. Original.

Control measures are the same as those recommended for the codling moth: thorough spraying with arsenate of lead just after the petals fall, and again the first of August.

Fig. 535. — Adult of the Lesser Apple Worm. Enlarged and natural size. Original.

The Grape Berry Moth (*Polychrosis viteana* Clem.)

Most "wormy" grapes, so often seen on vines, exhibit the characteristic work of the grape berry moth. While the berry is still green, a purplish spot appears on one side. If it is cut open, a small greenish or purplish caterpillar will be found within.

This is the larva of the second brood. Earlier in the season, when the grapes are in blossom or the berries are just forming, the inconspicuous first brood of caterpillars is on the vines, eating into the blossoms and tiny fruit, and webbing up the clusters.

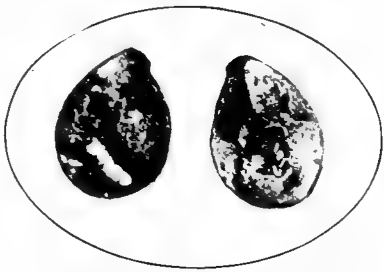

Fig. 536. — Section through grape, showing larva and work of the Grape Berry Moth. Original.

The insect overwinters as a pupa in a little cell made by

cutting out a small piece of a leaf. These cells break loose from the leaves after the latter fall. The moths emerge in the spring and lay eggs on the stems or fruit. The second brood of moths are out in July, and in the North there is a partial third brood in August.

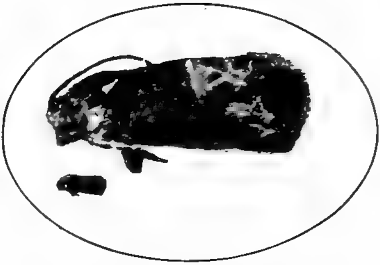

Fig. 537. — The Grape Berry Moth. Enlarged and natural size. Original.

Thorough and timely spraying with arsenate of lead will control this pest. The first spray must be applied just before blooming, the second just after, and the third when the berries are half grown. Soap may be added to the spray material to make it spread and stick to better advantage. If the vineyard is plowed in the fall, many of the overwintering pupæ will be buried or killed.

The Raspberry Byturus (*Byturus unicolor* Say)

The fruit of red raspberries sometimes is stunted by the work of this beetle and its grub. Occasionally the leaves are riddled by the feeding of the beetles.

The adult beetle is one seventh inch long, and brownish in color. It appears in spring, feeds on the foliage, and eats into the flower buds. In midsummer the grubs are at work and will be found in the thick white base on which the berry is borne. The grub is one fourth inch long, and marked across each segment with brown. Infested berries ripen early and are dwarfed. The larva spends the winter in the soil.

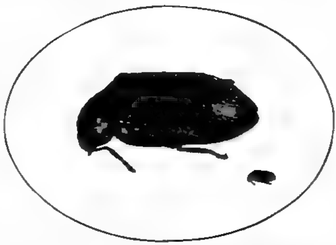

Fig. 538. — The Raspberry Byturus. Adult, enlarged and natural size. Original.

Control is best secured by spraying the foliage with arsenate of lead

or Paris green to poison the beetles when they appear in the spring. Since they feed freely on the leaves, the majority of them will be killed by an application of poison at this time.

The Apple Maggot (*Rhagoletis pomonella* Walsh)

In the northeastern states early or sweet apples, or sometimes late fruit, are often infested with the so-called "railroad worm," a small, whitish maggot which tunnels here and there through the pulp of the

Fig. 539. — Section through apple, showing characteristic work of the Apple Maggot. Original.

apple as it ripens, making a small, brown track wherever it goes. In thin-skinned varieties, these tunnels are apt to show through from the outside as wandering, brown tracks. This insect must clearly be distinguished from the common "apple worm" or codling moth, which eats preferably in and around the core and gnaws a large and conspicuous hole to the surface.

A two-winged fly, with oblique-banded wings, is the parent of the railroad worm. It appears in July, and lays its eggs, one at a time, under-

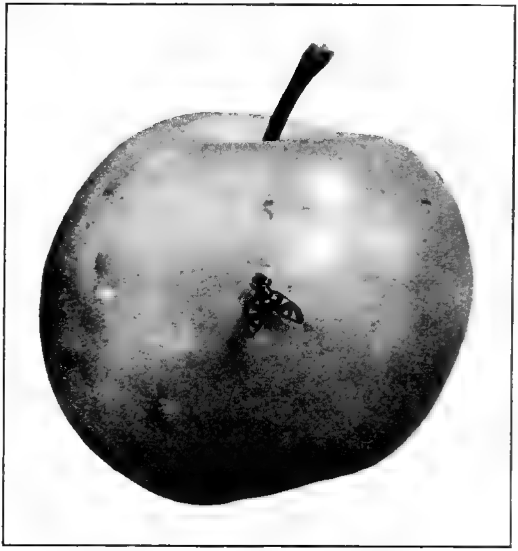

FIG. 540.—Adult of the Apple Maggot. Original.

neath the skin of the apple. The maggot feeds in the pulp, completing its growth after the apple has fallen from the tree and has become more or less mellow. It then bores its way out, enters the ground, and remains there until the following July.

FIG. 541.—Egg of the Apple Maggot, inserted beneath skin of fruit. Greatly enlarged. Original.

The maggot cannot be killed by spraying because it feeds wholly within the pulp of the fruit during its entire life. Control consists in keeping dropped fruit picked up, so that the maggots will not have a chance to enter the ground. Very early fruit should be picked up twice a week, fall fruit once a week, and winter fruit once in two or three weeks.

Live stock may be turned into an orchard to eat up the apples as they

drop. Pigs, sheep, or cattle will often accomplish this to good advantage. Chickens will hunt out and destroy many of the pupæ in the soil.

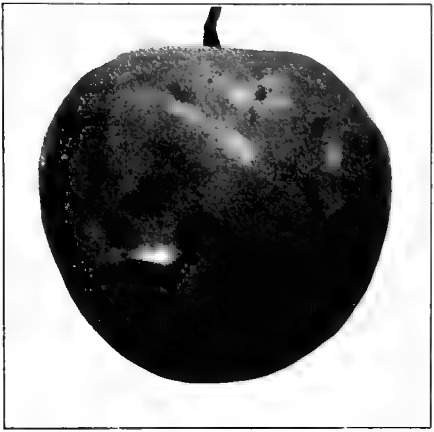

Fig. 542.—Burrows of the Apple Maggot, showing through skin of fruit. Original.

The Cherry Fruit Maggot (*Rhagoletis cingulata* Loew.)

Small, whitish, footless maggots about one third of an inch long are found in the pulp of ripening cherries, where they tunnel about, causing decayed cavities. The adult is a small fly with barred wings. Eggs are laid under the skin of the

Fig. 543.—Adult of the Cherry Fruit Maggot, enlarged and natural size. Original.

Fig. 544.—The Cherry Fruit Maggot. Larvæ, enlarged and natural size. Original.

fruit in midsummer. When full grown, the maggot leaves the fruit and enters the ground, its skin contracting and hardening to form a puparium. It remains there until the following season.

Where trees are badly infested, chickens may be made use of to scratch up and eat the puparia. No measures in the way of spraying are available.

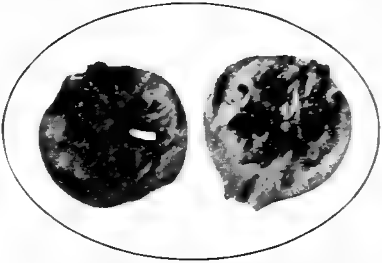

Fig. 545.—Section through young pear, showing work and larva of the Pear Midge. Original.

The Pear Midge

(*Contarinia pyrivora* Riley)

Early in the season the young fruit of pears becomes stunted and distorted. If a fruit is cut open, tiny maggots will be found within, working especially in and around the core.

Fig. 546. — Larvæ of the Pear Midge, enlarged and natural size. Original.

Eggs are laid when the buds first open by an exceedingly small midge. After completing its growth the maggot leaves the fruit and enters the ground, where it remains until the following spring. There is one brood annually.

No satisfactory means of control has been devised.

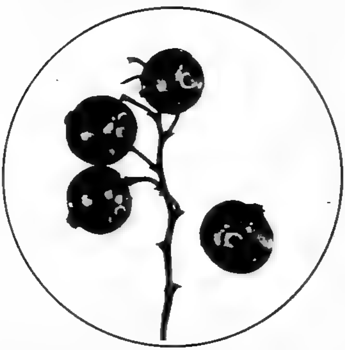

Fig. 547.—Work of the Currant Fruit-fly. Original.

The Currant Fruit-fly

(*Epochra canadensis* Loew.)

In early summer a small, white maggot may be found working in the berries of currants or gooseberries. The parent insect is a yellowish, two-winged fly with barred wings. Eggs are laid

under the skin of the fruit. Infested fruit usually falls to the ground. When full grown, the maggot bores out of the berry, enters the ground, and remains there until the following spring, when the adults issue once more.

Fig. 549. — The Currant Fruit-fly. Adult, enlarged and natural size. Original.

The use of poultry to pick up

Fig. 548. — Section through currant, showing work and larva of the Currant Fruit-fly. Enlarged. Original.

the fallen infested fruit is practically the only available remedy, unless it is feasible to have the fruit gathered by hand.

Fig. 550.—Work of a Plant-bug, *Lygus invitus*. Original.

The Tarnished Plant-bug

(*Lygus pratensis* Linn.)

A brownish bug, not over one fifth of an inch long when full grown, occasionally injures the buds and the young fruit on apple trees by sucking the juices. Buds are dwarfed or killed, and sometimes the fruit shows marked dimples or similar deformities, due to egg-laying punctures of the adults.

The adults hibernate in rubbish. If the

orchard and its surroundings are thoroughly cleaned of weeds and litter in the fall, there is not likely to be noticeable damage. The bugs may be jarred from small trees.

A related species, *Lygus invitus* Say, is a pest on pears, scarring the fruit by its feeding punctures.

FIG. 551.—Work of Apple Red Bugs. Original.

The Apple Red Bugs

(*Heterocordylus malinus* Reut., and *Lygidea mendax* Reut.)

Sucking bugs, about one fourth of an inch long, known as apple red bugs because of their brilliant color in their younger stages, puncture young fruit, causing it to grow distorted. There are two species, similar in appearance.

Eggs are inserted in the bark, and hatch in early spring. The young feed at first on the newly expanding foliage, making numerous punctures and giving the leaves at times a red appearance. Later they attack the fruit.

The remedy is to spray with tobacco extract just after the leaves expand and before the blossoms open, so as to kill the younger stages soon after they hatch from the egg. Soap may be added to the spray material.

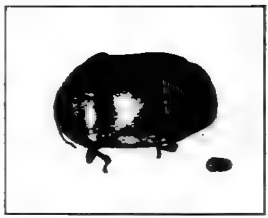

FIG. 552.—The Negro Bug. Enlarged and natural size. Original.

The Negro Bug (*Thyreocoris* (*Corimelæna*) *pulicaria* Germ.)

Exceedingly small, hard-shelled, shiny black bugs, resembling tiny beetles, sometimes feed on the ripe fruits of raspberry or blackberry, giving the fruit an unpleasant flavor. Usually they are not common enough to demand attention. No remedial measures are known.

CHAPTER XXIV

INSECT PESTS OF THE HOUSEHOLD AND STORED PRODUCTS

House Flies

THE commonest fly found in houses is the species properly known as the House Fly (*Musca domestica* Linn.). It is of medium size, grayish, and has mouth parts dilated at the end in a sort of lobe, fitted for taking up liquid food. Its early stages are passed in moist, decaying matter, especially horse manure or other excrement. These flies never bite; but they are pernicious visitors because of their filthy habits, and their known agency in the dissemination of disease.

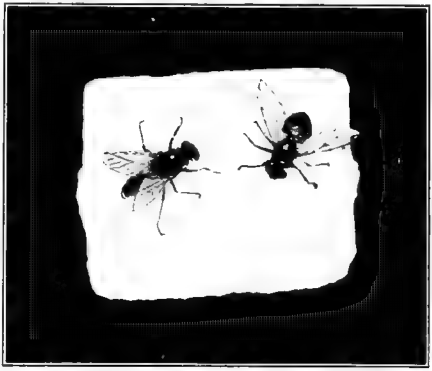

FIG. 553. — The House Fly. Original.

A second species, the Stable Fly (*Stomoxys calcitrans* Linn.), is the pest that annoys us by "biting," especially before storms. It has piercing mouth parts.

Other species often are observed, but the two named above are in the great majority, and of these two the house fly is by far the more numerous.

Since flies are known to carry disease, it is of prime importance to be rid of them in our homes. Proper screening is the first requisite, and nothing can be accomplished without this fundamental protection.

But in addition we must look to the breeding places, especially manure heaps. Usually the most feasible plan of caring for these is to inclose or otherwise screen them. If the manure can be removed once a week, flies cannot complete their life round in it.

FIG. 554. — The Stable Fly. Enlarged and natural size. Original.

An effective means of poisoning flies that have already gained access to a room is as follows:

Add two tablespoonfuls (1 ounce) of 40 per cent formalin to one pint (16 ounces) of sweet milk, or of equal parts milk and water. Pour this out in shallow plates, so that flies can get at it easily. A piece of bread placed in the middle of each plate will allow more space for flies to alight and feed.

Catching flies by means of traps, or with sticky fly paper, is a universal practice, and helps in reducing the numbers within a room, but the method described above will usually be found more rapid and effective.

Mosquitoes (*Culicidæ*)

Mosquitoes are of many species, but most have at least one point in common; their immature stages are found in stagnant water. They do not require breeding places of large area. An open rain-water barrel, an old watering trough, tin cans containing rain water; all such places provide suitable breeding ground.

The larvæ are familiarly known as "wrigglers," and live on minute animal or vegetable life, beneath the surface of the water. They must come to the surface occasionally to breathe. Following the larval, there is an active pupal stage, preceding the emergence of the adult.

The entire life round requires only ten days to two weeks under favorable circumstances.

Any thorough effort at control is best directed toward destroying the breeding places or preventing the insect from breeding in such as cannot be destroyed. The latter may be accomplished by pouring oil on the water, so as to prevent the larvæ from reaching the air when they come up to breathe. Large tanks above ground may be screened. In a word, stagnant water must be eliminated, or mosquitoes kept from it. In addition careful screening of houses is highly desirable, especially since some diseases are carried by certain species.

In clearing a room of mosquitoes a fairly satisfactory substance is available in pyrethrum, or "Persian insect powder." This may be heaped up in little piles on a pan and lighted; or, better, it may be poured out on a piece of tin or a pan set over a kerosene lamp. In the latter case not much smoke is given off, but the volatile oil that stupifies the insect permeates the air.

Another and successful fumigant consists of 1 part of saltpeter mixed with 3 parts of powdered jimson weed, and burned on a tin pan. Eight ounces to 1000 cubic feet is sufficient.

House Ants

The commonest ants in houses are the "little red ant," *Monomorium pharaonis* L., and a closely related species, somewhat larger and black in color, *Monomorium minutum* Mayr.

In getting rid of ants it is a great help if the main colonies can be hunted out and destroyed. The black ant lives outdoors, and enters the house through some convenient crack. The little red ant always has its nest in the walls or under the floors.

Either may be caught and killed in large numbers by saturating a sponge with sweetened water, placing it where they are abundant, and now and then dropping the sponge into boiling water. Scraps of bone or meat will do as well, and should be burned when well covered.

A successful method of fighting ants has recently been devised in California in the warfare against the notorious Argentine Ant (*Iridomyrmex humilis* Mayr.), which overruns dwellings, stores, and ware-

houses and is an intolerable pest. In this case it is not possible to hunt out and destroy the nests because they are made in every conceivable location. The plan consists in setting out numerous supplies of a dilute, slow-acting poison, which the foraging ants not only eat but carry back to the nests and feed to the young. By using a diluted poison the colony itself is slowly exterminated, as well as the foragers that go out from it.

Fig. 555. — The Little Red Ant. Enlarged and natural size. Original.

The poison is prepared by dissolving 5 pounds of sugar in $1\frac{1}{2}$ pints of water, placing it in a double boiler and heating gently. Then dissolve one fourth ounce of sodium arsenite in a little hot water, and add this to the syrup solution. Place a sponge in a can or a glass jar with a tin lid, and punch three or four holes in the lid. Moisten the sponge with the poisoned syrup. If ants avoid the jar after a time, move it slightly, and they will again visit it. In large buildings it is necessary to provide several of the jars for each floor. In residences from one to six jars usually will be sufficient. Often one will do the work.

The above material is *poisonous to human beings*, and proper care should be taken in its preparation and use.

The best barrier to prevent ants from gaining access to places where food is placed or stored is the so-called "ant tape." To make this prepare a saturated solution of corrosive sublimate and water by heating an excess of the crystals in water in a granite or porcelain vessel (not iron), cooling and filtering. Soak common cotton tape in this for several hours, then take out, hang up, and dry. Ants will not cross this tape. It will remain effective for a year, but must not be placed in contact with any iron, tin, or aluminum. It must be remembered that corrosive sublimate is a *dangerous poison*.

Roaches

At least four species of roaches are common in the United States: the American Cockroach (*Periplaneta americana* Linn.), the Oriental Cockroach (*Blatta orientalis* Linn.), the Australian Roach (*Periplaneta australasiæ* Fab.), and the German Roach, or " Croton Bug " (*Blatella germanica* Linn.).

All are more or less domesticated, eat any kind of food product, and leave behind them a disgusting odor.

In some species both males and females are winged, while in others the female has only short remnants of wings. All are alike in having

FIG. 556. — The German Roach, or "Croton Bug." Slightly enlarged. Original.

flat, thin bodies, and strong, biting jaws. The young look much like the adults, but are of course much smaller. From one to three years are required for their development.

A number of prepared poisons are on the market for the destruction of roaches, and some of these are fairly effective. Various traps are employed. Large numbers may be killed by setting out two shallow dishes, one containing flour and plaster of Paris mixed together, and

the other water. Use four parts of flour to one part of plaster of Paris. Arrange the dishes so that roaches can easily climb on them and pass from one to the other. Badly infested buildings may be entirely cleared by fumigation with hydrocyanic acid gas. Great care should be taken in using this treatment, for it is *violently poisonous.*

Fleas

Fleas are too well known to need description. Where houses become infested, the trouble is nearly always traceable to a pet cat or dog, although the pest may be brought in on clothing of a visitor. The species usually observed is the common Cat and Dog Flea (*Ctenocephalus canis* Curt.).

Fig. 557.—The Cat and Dog Flea. Enlarged and natural size. Original.

The adult flea lays eggs among the hairs of its animal host. These drop off, and the egg hatches to form a minute, white, slender larva, which lives in cracks in the floor or other protected places, feeding on any available organic matter, such as hairs, or even dust. The larva transforms to a pupa, and later the adult emerges, ready to leap on the first cat or dog that comes its way, or on a human being.

To rid a house of fleas all cracks must be washed with hot suds, and preferably dosed with gasoline. At the same time any animal pets must be looked after and cleared of the insect. Insect powder dusted thoroughly into the animal's fur will stupefy the fleas and cause them to drop off. They may then be gathered up and destroyed.

Another treatment is to scatter over the floor of a room 4 or 5 pounds of naphthaline, and keep the place tightly closed for 24 hours. This will effectually rid a room of the adult insects, but will not be likely to affect any eggs that might be present. The naphthaline may be swept up and used over again.

The Bedbug (*Cimex lectularius* Linn.)

The bedbug is an ancient and cosmopolitan insect, existing throughout the world. It has become wholly domesticated, and lives entirely

in human dwellings, hiding away in crevices by day, and coming out to suck the blood of its unfortunate host by night. Normally its life round requires about three months, but it can exist for a long time in a house temporarily vacated. In cities it sometimes migrates from vacant residences to others near by that are occupied. The young are similar in shape to the adults, and, like their parents, have a strong sucking beak.

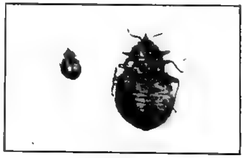

Fig. 558. — The Bedbug. Enlarged and natural size. Original.

A thorough course of treatment of all hiding places is necessary for their eradication, unless it is possible to vacate a house for two or three days and fumigate with hydrocyanic acid gas. Gasoline, corrosive sublimate, or turpentine may be used in cracks to kill them. In vacant houses sulphur may be burned, using it at the rate of 2 pounds to the 100 cubic feet, and placing the material in a metal or earthen dish, which should in turn be placed within a larger dish, to guard against danger of fire.

Fig. 559. — Head of Bedbug. Greatly enlarged. Original.

The Clothes Moths

Several species of tiny, dusky moths lay eggs in woolens or furs, the resulting larvæ feeding on the garments, eating holes in them, and often doing irreparable damage. The larva of a common species, *Tinea pellionella* L., makes a little case within which it feeds.

In the Northern states this particular species occurs in the larval state — the only stage in which it is directly destructive — in summer only. In the South it may occur all the year. The adults are on the wing at any time in the warmer months. They are active and shy, and avoid the light.

Attack is most severe on winter clothing laid away for the summer. Garments should be hung out in the sunlight and thoroughly brushed

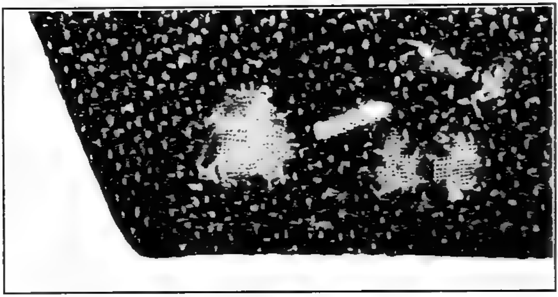

Fig. 560. — Work of Clothes Moths. Original.

or beaten before being packed away. They may then be inclosed in boxes, and the cracks sealed with gummed paper. This work should be done before hot weather has arrived. Deterrants, such as naphtha-

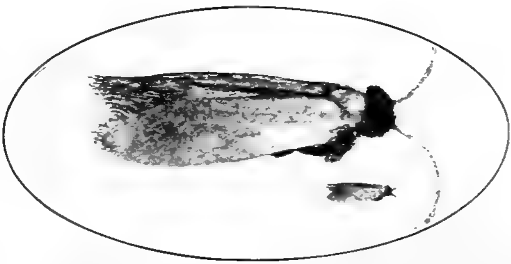

Fig. 561. — A Clothes Moth, *Tinea pellionella.* Enlarged and natural size. Original.

line or moth balls, are of moderate value. Upholstered furniture and the like should be sprayed or sponged with gasoline two or three times in summer.

The Carpet Beetle, or Buffalo Moth (*Anthrenus scrophulariæ* L.)

A small, hairy, oval larva, about one fourth of an inch long, feeds on carpets, working from the under side, and usually following the line of a crack in the floor. The adult is a beetle, three sixteenths of an inch in

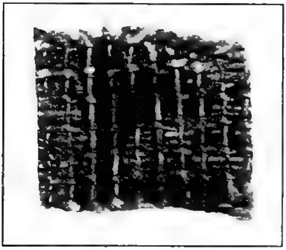

FIG. 562. — Work of the Carpet Beetle. Original.

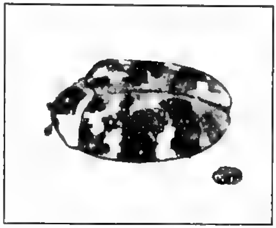

FIG. 563.—The Carpet Beetle. Enlarged and natural size. Original.

length, dark in color, and irregularly mottled with white. The beetles appear through the fall and winter.

Where rugs are used, no damage is recorded as a rule. If carpets are necessary, and infestation is in progress, it is essential to take up the floor coverings, spray them with gasoline, and wash all cracks with hot suds, following with gasoline.

The Silver Fish (*Lepisma saccharina* L.)

Substances containing sugar, starch, or sizing are sometimes injured by a tiny, active, wingless insect of a silvery appearance, having very long antennæ and three long feelers at the hind end of the body. It invariably runs quickly away when objects on which it is at work are brought to the light.

Pyrethrum dusted into places where it hides will kill them, or they may be poisoned by dipping pieces of cardboard into a thick paste in which has been mixed Paris green, and slipping these into cracks where they are abundant.

The Cheese Skipper (*Piophila casei*)

The softer kinds of cheese and the fatty parts of hams or bacon are the favorite breeding places of minute, slender maggots that have a way of curling the body and then suddenly straightening it, so that they throw themselves some little distance. They are the larvæ of very small, grayish flies.

Infested materials should be removed, and shelving or bins given a thorough cleaning, for the maggots will develop in very small quantities of grease or other suitable material. It is sometimes necessary to fumigate, in order to kill the adult flies that are in hiding.

The Angoumois Grain-moth (*Sitotroga cerealella* Oliv.)

In the Southern states stored grain is severely attacked by a very small grub which starts work within the kernels in the field, and continues its depredations after the grain is harvested and stored. The

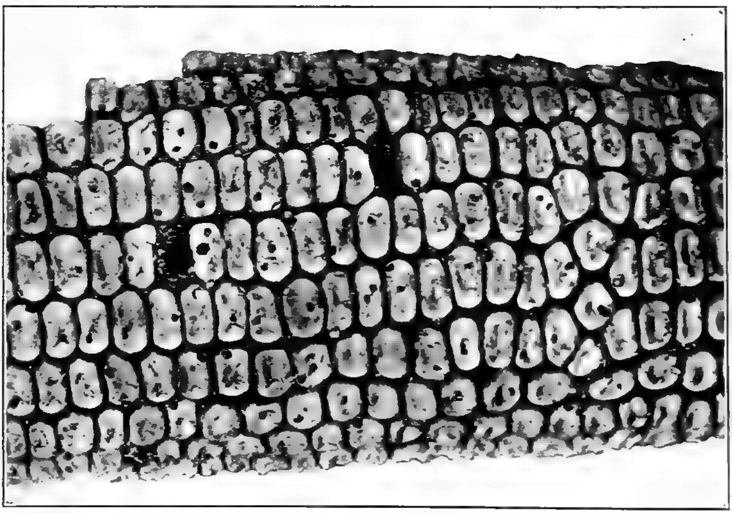

Fig. 564. — Work of the Angoumois Grain-moth. Original.

outward evidence of its work is seen in tiny, round holes through the hard outer coating of the grain, showing where adults have emerged. Frequently the adult moths, small, buff-colored "millers," are noticeably abundant, especially at threshing time.

There are half a dozen or more generations in the course of the year. The earliest moths in spring at once fly to the grain fields and two or three generations are reared in the growing kernels. The grubs of the last are harvested along with the grain, and the work goes on as long as warm weather lasts. Corn usually becomes infested only after being husked, the moths flying to it and laying eggs on it.

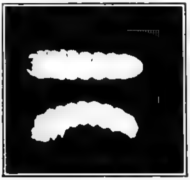

Fig. 565. — Larvæ of the Angoumois Grain-moth. Enlarged to twice natural size. Original.

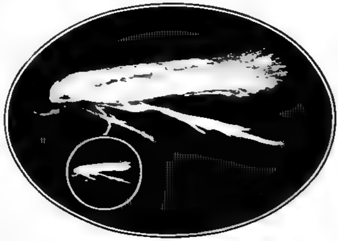

Fig. 566. — The Angoumois Grain-moth. Enlarged and natural size. Original.

In control, grain should be threshed as soon as harvested. It should be stored in tight bins, watched carefully, and if it heats, indicating the presence of the pest, should be fumigated at once with carbon bisulphide. Corn husked late and placed in open cribs out doors seldom becomes infested.

Fig. 567. — The European Grain-moth. Enlarged and natural size. Original.

The European Grain-moth (*Tinea granella* Linn.)

A tiny moth, with brown and white spotted wings, lays its eggs on developing grains in the field, its minute grubs feeding within the kernels in similar fashion to the Angoumois grain moth. It continues to breed in stored grains, just as does the other insect named, but its work may readily be

distinguished from the fact that there is always more or less webbing over the grain. Remedies consist in prompt threshing, storing in tight bins, and fumigation with carbon bisulphide as soon as the presence of the pest is discovered.

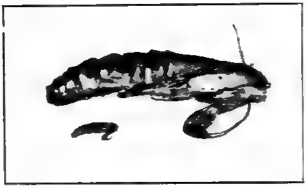

FIG. 568. — Empty pupal skin of the European Grain-moth. Enlarged and natural size. Original.

The Mediterranean Flour Moth
(*Ephestia kuehniella* Zell.)

This imported pest now ranks as one of the most destructive and troublesome of the insects infesting stored flour, bran, buckwheat, crackers, and cereal foods. It is the immature stage of a dull gray moth, expanding about one inch. The full grown larva is a half inch long, white, ornamented with fine

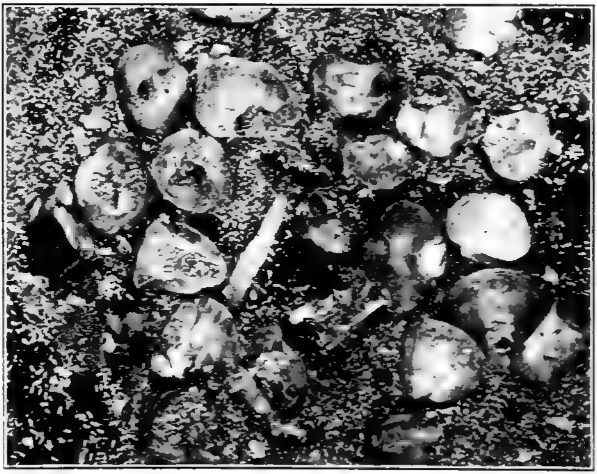

FIG. 569. — Work of the Mediterranean Flour Moth. Original.

black dots, and sparsely covered with hairs. It feeds within a silk tube, and spins quantities of silk wherever it goes, especially when

traveling about before pupation, with the result that the material in which it is at work is matted together and rendered valueless. In most situations, breeding goes on continuously.

Remedies consist of fumigation with hydrocyanic acid gas. Treatment by heat is now gaining in favor, and promises to be a valuable method. This treatment is described under the following insect.

FIG. 570. — Larva of the Mediterranean Flour Moth. Slightly enlarged. Original.

FIG. 571. — The Mediterranean Flour Moth. Slightly enlarged. Original.

The Indian-meal Moth (*Plodia interpunctella* Hbn.)

Stored grains and flours of many kinds frequently become infested with the larvæ of this tiny moth, which travel here and there through the grain or meal, eating as they go, and always spinning quantities of web with which will be found mixed the castings of the worms. The larva is about a half inch long, whitish or pale pink or greenish.

In heated warehouses breeding may go on throughout the year. The adult is a small moth, expanding one half to three fourths of an inch, the fore wings reddish brown in their outer parts, the hind wings gray.

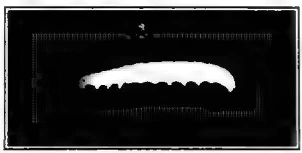

FIG. 572. — The Indian-meal Moth. Larva. Slightly enlarged. Original.

In elevators or warehouses that are heated by steam the pest may be treated successfully by heat. If the temperature throughout the building can be raised to 120 degrees Fahrenheit, and maintained at that point for 6 hours, practically all

FIG. 573.—Adult of the Indian-meal Moth. Enlarged and natural size. Original.

of the insects will be killed. Some additional piping may be necessary in order to accomplish this, but usually the cost is justified by the results, and the improvement, once made, is permanent.

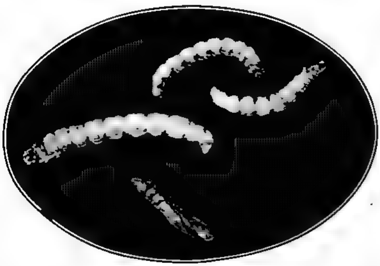

FIG. 574.—Larvæ and pupa of the Meal Snout-moth. Slightly enlarged. Original.

The pest may be killed by fumigation with carbon bisulphide or hydrocyanic acid gas.

The Meal Snout-moth (*Pyralis farinalis* Linn.)

The habits of this species resemble those of the Indian-meal moth. The larvæ work in grains or grain products, such as flour, bran, or meal, and spin long tubes of silk, ruining more than they consume. There are three or four generations annually under favorable conditions.

Treatment is the same as for the preceding species.

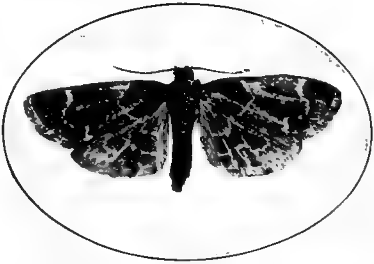

FIG. 575.—The Meal Snout-moth. Slightly enlarged. Original.

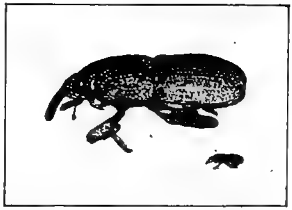

FIG. 576.—The Granary Weevil. Enlarged and natural size. Original.

FIG. 577.—Work of the Rice Weevil. Original.

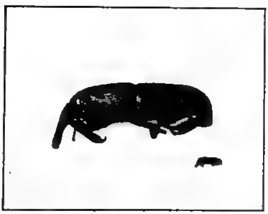

FIG. 578.—The Rice Weevil. Enlarged and natural size. Original.

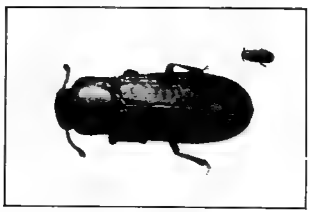

FIG. 579.—The Confused Flour Beetle. Enlarged and natural size. Original.

Beetles and Weevils in Stored Products

Stored grain and other stored products are subject to infestation by many species of small beetles. In most cases the greater part of the injury is due to the feeding of "grubs," which are the immature stages of the pest concerned, but since the grubs often work concealed, while the adults are active and visible, the latter are the stages commonly noted. Some of the species most likely to be observed are the following:

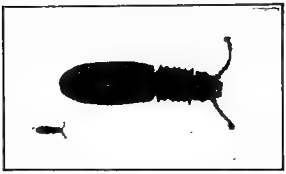

Fig. 580.—The Saw-Toothed Grain Beetle. Enlarged and natural size. Original.

The Granary Weevil (*Calandra granaria* Linn.). A brown snout-beetle, one seventh of an inch long. Infests stored grains, especially wheat, corn, and barley. The wings are not functional, and the insect cannot fly.

The Rice Weevil (*Calandra oryza* Linn.). A dark brown snout-beetle with two obscure, slightly lighter markings on each wing cover. Attacks stored grains; also such manufactured products as crackers, flour, and the like. The adult can fly.

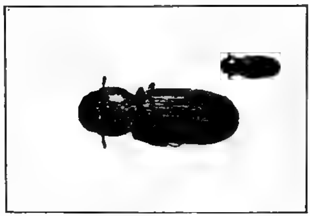

Fig. 581.—The Cadelle. Enlarged and natural size. Original.

The Confused Flour Beetle (*Tribolium confusum* Duv.). A flat, brown beetle, one sixth of an inch long. A destructive pest of flour, cereal foods, and grains.

The Rust-red Flour Beetle (*Tribolium navale* Fab.). Closely resembles the preceding species. The same feeding habits.

The Saw-toothed Grain Beetle (*Silvanus surinamensis* Linn.). A slender, dark brown beetle, its thorax edged with short teeth. Found in all kinds of foodstuffs.

The Cadelle (*Tenebroides mauritanicus* Linn.). A black, oblong beetle, one third of an inch in length. The larva whitish, fleshy, tapering

somewhat toward each end, three fourths of an inch long. Feeds on the germ of grains. Adults and larvæ also predaceous.

For all of these pests the surest treatment is fumigation with carbon bisulphide or carbon tetrachloride. They may be killed, also, by heating the material in which they are at work to a temperature of 125 to 140 degrees for three or four hours.

When foodstuffs in houses are infested, a thorough cleaning out of the storage places is necessary, together with proper treatment of the materials affected. In addition all cracks and crevices should be sprayed with gasoline, taking proper precautions to guard against fire.

The Bean Weevil (*Acanthoscelides* (*Bruchus*) *obtectus* Say)

Dried beans that have been gathered and stored for winter use are injured or destroyed by this insect. Many beans will be found showing

Fig. 582. — Work of the Bean Weevil. Original.

round holes where the adult weevils have emerged, others will have grubs still at work inside, and in the box or bin will be found numerous

small, mottled, brownish beetles, about one eighth of an inch long, their wing covers a little shorter than their bodies.

Infestation may have been carried over from old beans left in the box from last season's crop, for the insect continues to breed through the year in stored beans. Or the eggs may have been laid in the beans while still on the vines in the field, the beetles being abroad on the wing in late summer.

Fumigation with carbon bisulphide or carbon tetrachloride is the best treatment, and should be applied as soon as beans are gathered. Infested beans should not be planted for seed.

Fig. 583. — The Bean Weevil. Adult, enlarged and natural size. Original.

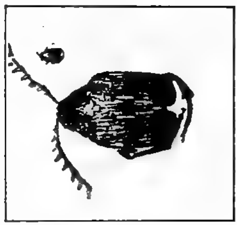

Fig. 584. — The Cowpea Weevil. Enlarged and natural size. Original.

The Cowpea Weevil (*Pachymerus* (*Bruchus*) *chinensis* L.)

Stored beans, peas, and cowpeas are attacked by this weevil. In most particulars its life round is the same as that of the bean weevil. It continues to breed in the stored seed.

Treatment consists in fumigation with carbon bisulphide or carbon tetrachloride.

The Four-spotted Bean Weevil (*Pachymerus* (*Bruchus*) *quadrimaculatus* Fab.)

Still another weevil working in dried beans and peas is the four-spotted bean weevil. While the adult differs somewhat from the pre-

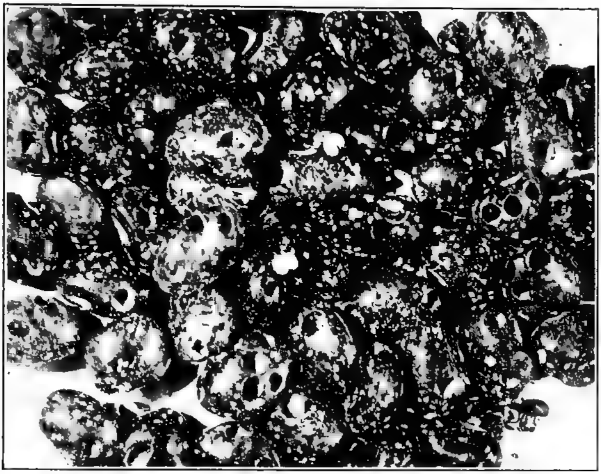

Fig. 585. — Work of the Four-spotted Bean Weevil. Original.

ceding in shape and markings, its habits and life history are practically the same. It lays eggs in the field, but also continues to breed in the dried, stored product.

The treatment is fumigation with carbon bisulphide or carbon tetrachloride.

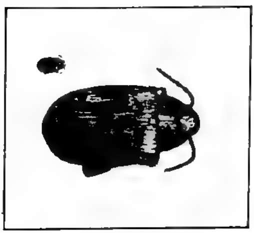

Fig. 586. — The Four-spotted Bean Weevil. Enlarged and natural size. Original.

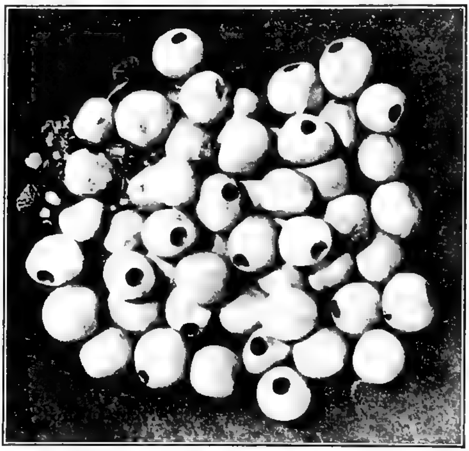

Fig. 587. — Work of the Pea Weevil. Original.

The Pea Weevil (*Laria (Bruchus) pisorum* L.)

The adult pea weevil is similar in appearance to the bean weevil, but is a little larger and has a shorter thorax. The grubs live in peas, hatching from eggs laid on the pods early in the season by the adults, while the peas are still in the field. Unlike the bean weevil this pest never goes on breeding in the dried, stored product.

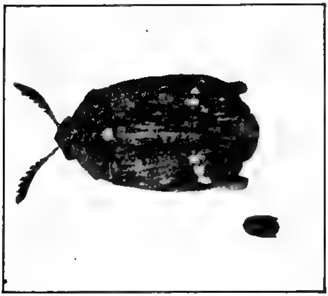

FIG. 588. — The Pea Weevil. Enlarged and natural size. Original.

The grubs are in the peas when they are gathered. In the South the adults emerge before the next planting time, but in the North the insect is still in the seed when it is planted.

Emergence of the adults may be accelerated by keeping the peas in a warm place. Seed may be held over for a season. The best treatment, however, is fumigation with carbon bisulphide or carbon tetrachloride.

Weevils in Nuts

The white, thick grubs often found in chestnuts, pecans, and hickory nuts are familiar to all. Their exit holes also, where the mature grub has cut its way out through the shell, are commonly recognized.

The adults of these grubs are beetles, one fourth to one third inch long, yellowish in general color with darker markings, and characterized by an extremely long snout, slender as a pin. Biting jaws are located at the end of the snout.

There are three species concerned: the Larger Chestnut Weevil (*Balaninus proboscideus* Fab.); the Chestnut Weevil (*Balaninus rectus* Say); and the Pecan, or Hickory Nut Weevil (*Balaninus caryæ* Horn.). All are similar in appearance, and their habits are much the same.

Direct means of control of these pests in the field is not possible.

The adults come out from the ground in spring, and continue emerging throughout the summer. When the nuts are large enough, they puncture them through the husk or burr with their long snouts, and lay their eggs within. The grubs mature usually soon after the nuts fall, eat their way out, and winter in the soil.

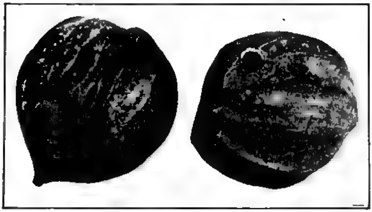

FIG. 589. — Work of the Hickory Nut Weevil. Original.

Nuts should be gathered regularly and at frequent intervals. In the case of chestnuts it is wise to fumigate with carbon bisulphide immediately after gathering. The gas will penetrate the nuts and kill the weevils, some of which will be so small that they have not yet damaged the kernel appreciably.

The Yellow Mealworm (*Tenebrio molitor* Linn.)

Corn meal or similar material is often infested with yellowish or brownish worms, an inch long when full grown, their backs shining and "hard-shelled," looking somewhat like wireworms. The adult is a

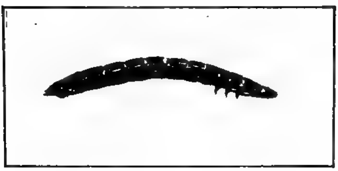

FIG. 590. — The Yellow Mealworm. Slightly enlarged. Original.

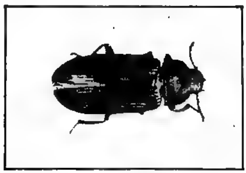

FIG. 591. — Adult of the Yellow Mealworm. Slightly enlarged. Original.

dark, oblong beetle, which flies at night, and lays eggs wherever it can find suitable material. Treatment consists in a thorough cleaning up of waste meal, combined with fumigation or heating of infested lots. There is only one generation annually.

The Cigarette Beetle (*Lasioderma serricorne* Fab.)

Stored tobacco, and various other stored products, often become infested with this pest. The larvæ is a white, fleshy, tiny grub. The adult is one sixteenth of an inch long, brownish, its head bent back under its thorax. The larvæ feed here and there through their food substance, and the beetles make small round holes in emerging. There are several generations annually under suitable conditions. Warehouses that have become infested should be thoroughly cleaned up, and then fumigated with carbon bisulphide or hydrocyanic acid gas.

Fig. 592. — Work and larva of the Cigarette Beetle. Enlarged. Original.

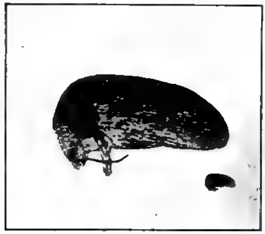

Fig. 593. — The Cigarette Beetle. Adult, enlarged and natural size. Original.

CHAPTER XXV

Insect Pests of Domestic Animals

Many different species of insects live as parasites on or in domestic animals. Some of these have totally different habits and characteristics; and thus the treatment for one will not always answer for another. But between many species only minor differences exist. The commoner and more typical forms will be given here.

The Horse Bot-fly (*Gastrophilus equi* Fab.)

In its larval stage this insect is an internal parasite within the stomach of the horse, where it lives attached to the walls. It injures the animal by interfering with digestion and by the irritation set up by its presence.

The adult fly frequents horses throughout midsum-

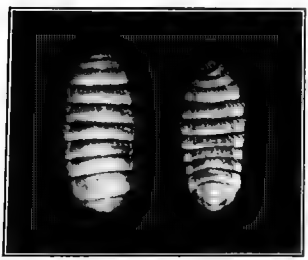

Fig. 594. — Larvæ of the Horse Bot-fly. Slightly enlarged. Original.

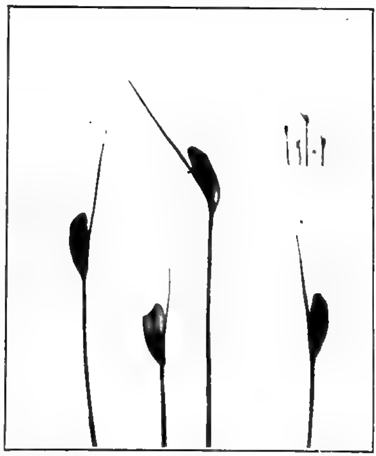

Fig. 595. — Eggs of the Horse Bot-fly, attached to hairs. Enlarged and natural size. Original.

mer, and fastens its eggs to the hairs of the animal's shoulders or fore legs. The eggs are yellowish in color and plainly visible. They are hatched by the action of the animal's tongue in licking itself, and are carried by the tongue to the mouth, whence they reach the stomach. When full grown, the larvæ pass out and pupate in the soil.

FIG. 596. — The Horse Bot-fly. Slightly enlarged. Original.

Examine the stock once every two weeks during summer, and if eggs are found, shave them off with a sharp knife or moisten them with kerosene, or with a solution of carbolic acid 1 part, water 30 parts.

The Sheep Bot-fly (*Œstrus ovis* Linn.)

The maggots of this species develop in the upper nasal passages of sheep, sometimes penetrating the brain. Living young are deposited in the nostrils by the adult flies in June and July. The mature maggots work their way out through the nostrils after ten months and pupate in the ground.

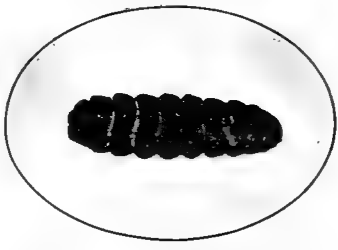

FIG. 597. — Larva of the Sheep Bot-fly. Slightly enlarged. Original.

Finely powdered lime is used to induce sneezing, so as to dislodge the maggots. The same result is secured by dipping a feather in turpentine and running it up the nostrils. A mixture of tar and grease or other repellent may be smeared on the nose to keep off the adult flies, but is not entirely effectual.

The Ox Warble (*Hypoderma lineata* Villers)

The ox warble is a species of bot-fly, which spends the latter part of its larval stage as a fleshy, footless grub beneath the skin of the back.

A hole is made through the skin by which the grub gets air. These holes are a source of great loss in dressed hides, and the presence of the grub causes irritation and often loss of weight or of milk flow in the infested animal.

The adult is about the size and shape of a honey-bee, but has only two wings instead of four. The sides of its head and thorax are marked with white, and on the upper surface of the thorax are four shining raised lines. The base of the abdomen is whitish.

Eggs are laid in early summer attached to hairs near the heels of the animal. The egg opens as the animal licks its heels, and the young grub is carried by the tongue to the mouth. It at once penetrates the walls of the throat and for several months is in the connective tissue along the back of the neck and elsewhere. Finally it settles under the skin of the back, and makes its breathing hole through the hide. When mature, it drops to the ground, where it remains until the next spring.

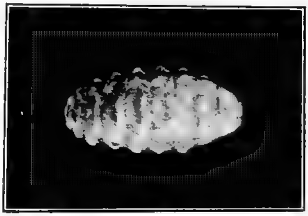

FIG. 598. — Larva of the Ox Warble. Original.

The presence of the grub results in damage to the beef, giving it a slimy appearance. In addition the hide is injured.

Flies will not lay eggs on animals that are standing in water. In small herds strong-smelling oils may be smeared on the lower part of the legs, and will act as deterrents. A mixture sometimes recommended consists of sulphur, 4 ounces; spirits of tar, 1 gill; train oil (whale oil), 1 quart. As a rule the adult flies do not enter stables or attack animals under shelter.

The grubs under the skin are best removed by pressing each side of the hole until the end of the grub protrudes, and drawing it out with tweezers.

The best time to do this is in February or March. The grubs can be located by passing the hand along the back. If the grubs are thus removed, the flesh beneath will heal and the hole will close within a short time.

The Screw-worm (*Chrysomyia macellaria* Fab.)

Exposed wounds or even the bites of ticks form the breeding ground of the whitish maggots of this species. Eggs are laid in large numbers in such places by the adult fly, and the young burrow in the surrounding tissues, later entering the ground to transform. There may be several generations annually.

Fig. 599. — The Screw-worm Fly. Enlarged and natural size. Original.

Prompt treatment of chance wounds, and dipping to kill or prevent ticks, are the best measures to adopt. In the treatment of wounds a solution of carbolic acid, 1 part, water, 30 parts, is excellent, followed by a dressing of pine tar.

Sucking Lice on Domestic Animals

The larger animals, including cattle, horses, swine, and others, are often infested with sucking lice, which frequently cause great irritation. Several species are common.

The Short-nosed Ox Louse (*Hæmatopinus eurysternus* Nitzsch) is slaty in color, one eighth to one fifth of an inch long and about half as broad. Usually it is most troublesome on the neck and shoulders.

Fig. 600. — The Short-nosed Ox Louse. Enlarged and natural size. Original.

The Long-nosed Ox Louse (*Hæmatopinus vituli* Linn.) is slender, one eighth of an inch long. Its head is distinctly elongated.

The Hog Louse (*Hæmatopinus urius* Nitzsch) is gray, one fourth of an inch long, the body broadly elliptical, the head narrow. Badly infested pigs fail to make proper gains in weight.

For all of these pests, treatment consists in the application of suitable contact insecticides, which may be kerosene emulsion, tobacco extract, or various ointments. Kerosene emulsion should be prepared by diluting the stock emulsion with 8 or 10 parts of water. "Black leaf 40," or "nicotine sulphate," is diluted at the rate of 1 part to 800 of water.

FIG. 601. — The Long-nosed Ox Louse. Enlarged and natural size. Original.

Biting Lice on Domestic Animals

Various species of flat-bodied, broad-headed, biting lice infest the larger animals. They feed on the rough parts of the skin and on the hairs, and cause considerable irritation, though they do not suck the blood. Commonly they are spoken of as the "little red lice," as distinguished from the bluish sucking lice. All are members of the genus *Trichodectes*. *T. scalaris* Nitz. infests cattle; *T. parumpilosus* Piag. is common on the horse; *T. sphærocephalus* Nitz. is found on the sheep.

Washes of kerosene emulsion or tobacco extract are effective, as described for sucking lice.

The Cattle-tick (*Margaropus annulatus* Say)

Throughout many of the Southern states cattle are subject to a fever which is transmitted by a tick. Enormous losses are caused each year by the work of this pest. The tick which serves as a carrier for this disease is a dark-bodied, eight-legged creature, and goes through a peculiar life round. The adult engorged female drops from the cattle to the ground and lays its eggs. These hatch into "seed ticks," which then crawl up on the nearest herbage and wait for cattle to come along. Once back on an animal host, they go through their life round to adult.

FIG. 602. — The Cattle-tick. Slightly enlarged. Original.

Control is based on keeping cattle out of tick-infested pastures long enough to starve out all the seed ticks. The latter do not go in search of a host, but wait for it to come. Luckily this scheme works in well with various desirable crop rotations.

In the case of range animals, dipping or spraying to kill the ticks on the animal is resorted to.

The Sheep Tick (*Melophagus ovinus* Linn.)

Degenerate, reddish or brownish, flattened insects, one fourth of an inch long or less, suck the blood of sheep and lambs. They are especially injurious to the latter. The pest is most numerous in the spring months. The entire life round is spent on the sheep. While this species belongs in the order of flies, the adults are entirely wingless.

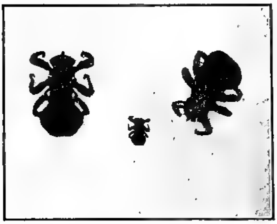

Fig. 603.—The Sheep Tick. Enlarged and natural size. Original.

Sheep should be dipped after shearing. Various substances are on the market for this purpose. Or, one of the commercial tobacco extracts may be used, following the instructions printed on the container in which the material is sold.

The Sheep Scab-mite (*Psoroptes communis* Furst, var. *ovis*)

Small, sucking mites breed in large numbers under scales or crusts formed on the skin of sheep. There is violent itching, and the wool looks rough and ragged, often sticking together in places, or falling entirely out. Attack is usually confined to the neck, back, and rump, the under parts being more or less free of the mites. The mites are exceedingly small, and swarm around the edges of the scabs.

Dipping of infested animals is the only thorough remedy. The same materials are used as in dipping for the sheep tick, the one dip serving to kill both insects.

Biting Lice on Poultry

Several different species of biting lice affect poultry, including the genera *Menopon*, *Lipeurus*, and others. They vary in particular characteristics, but all are alike in the fact that they do not suck the blood of their host, but cause injury by eating the surface of the skin and the finer parts of the feathers, and by the tiny pricks of their sharp claws as they move about over their host. On young chicks their irritation may readily prove fatal.

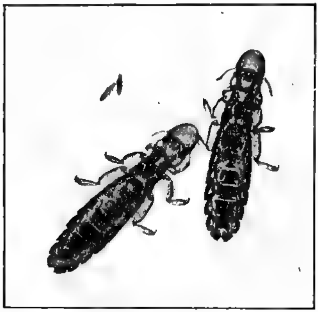

FIG. 604.—A Chicken Louse, *Lipeurus variabilis.* Enlarged and natural size. Original.

The eggs or "nits" are laid on the feathers, and in warm weather hatch in ten days. Both young and adults are apt to be especially active at night, crawling over the perches and moving from one fowl to another.

Treatment must include both the poultry house and the fowls in order to be entirely effective. The latter may be dusted with a mixture of 10 pounds of sulphur to $\frac{1}{2}$ bushel of air-slaked lime. The same material may be used in the house, taking care to get it into all cracks, and mixing it with the dust bath. A more effective measure for the house is spraying with lime-sulphur solution or 10 per cent kerosene emulsion. Treatment of the fowls should be repeated at the end of a week or ten days.

The Chicken Mite (*Dermanyssus gallinæ* Redi.)

Several species of mites attack poultry, but the commonest is the one here described. It is a minute, eight-legged creature, one twentieth of an inch long, normally grayish in color but appearing red when filled with blood. It has sucking mouth parts.

Eggs are laid in droppings or in places where dirt has accumulated, and the young feed at first on such substances. Later they crawl on

hens or young chicks, but they do not remain on them all the time, usually feeding only at night or when a hen is on a nest, and hiding in cracks in the henhouse during daytime. Often they will be found during the day clustered in little colonies on the under side of perches, especially in crevices in the wood.

In control the first measure is a thorough cleaning up of the poultry house. Then spray the interior with lime-sulphur solution or with 20 per cent kerosene emulsion. The spraying treatment should be repeated after a few days.

FIG. 605. — The Chicken Mite. Enlarged and natural size. Original.

The Itch Mite of Poultry (*Cnemidocoptes mutans* Robin.)

This pest is related to the common chicken mite, but attacks rather the legs, the comb, or the neck, where it burrows under the skin, causing a scaly crust to form.

Dry, sunny quarters should be provided for fowls attacked. The legs or other affected parts should be washed in warm soap and water, followed by the application of a suitable ointment, which should be one containing sulphur.

Another species, *Cnemidocoptes gallinæ* Railliet, causes such irritation that the fowls pull out their feathers; or the feathers break off. A whitish, powdery substance will be found in the base of the quills, and in this the lice live.

Give the same treatment as for the other itch mite, just described.

The Cuban Hen Flea (*Argopsylla gallinacea* West.)

In the Southern states this species of flea seriously infests fowls and sometimes is a nuisance to man. On fowls, the fleas collect in large numbers on spots bare of feathers, such as the comb or wattles, bury their sucking mouth parts in the flesh, and stick so tight that they can hardly be dislodged. The young develop in waste matter in the nest or on the ground.

The remedies are suitable ointments or washes.

Horseflies, or "Gadflies" (*Tabanidæ*)

Horses and cattle, and often other animals as well, are persecuted by various species of large, two-winged flies, which alight on the head, neck, back, or flanks, and torment the animals by piercing the skin and sucking the blood. The pests are capable of causing noticeable loss of flesh, not to mention the unpleasant effects on the animal's disposition.

These flies have no connection with the bots or grubs found in the stomach of the horse or under the skin of the back of cattle. Their sole injury is that caused by their bites. Their young live in pools or running streams, and their eggs are laid on leaves or twigs overhanging the water.

Various oils may be applied to the animals, to drive away the flies. One method is to spray them with kerosene emulsion, diluting the stock with 10 parts of water.

The Horn-fly (*Lyperosia irritans* Linn., formerly *Hæmatobia serrata*)

The horn-fly is a biting insect about the size of a common house fly but more slender, and injures cattle by swarming on them in large numbers, biting and annoying them severely. The fly gets its name from its habit of resting in clusters around the base of the horns, where it cannot be dislodged by its host. It does not feed at this point particularly, but rather on the flanks, belly, and wherever opportunity offers.

FIG. 606. — The Horn-fly. Enlarged and natural size. Original.

There are several generations annually. The larva is a small maggot, and lives in moist, fresh dung.

If all dung is collected frequently and spread out to dry, the maggots will be killed. Cattle may be protected by repellents, among which fish oil or train oil is the best. Kerosene emulsion, applied with a spray pump, will kill such flies as it hits, and will give protection for two or three days.

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Detailed accounts of the insects considered in this book will be found in the following bulletins and reports.

Abbreviations

Bur. Ent.=Bureau of Entomology, United States Department of Agriculture.

Exp. Sta.=The various State Experiment Stations.

Rpt. State Ent.= Annual Reports of the various State Entomologists.

Farmers' Bull.= Farmers' Bulletin, United States Department of Agriculture.

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